# Technical Memorandum



808 SW 3<sup>rd</sup> Avenue Suite 300 Portland, OR 97204 Phone (503) 287-6825 Fax (503) 415-2304 To: Mike Peebles, PE

From: Tammi Connolly, PE

Jeremy Tamargo, EIT

Copies: File

Date: December 2, 2015

**Subject:** South Cooper Mountain Heights

Preliminary Drainage Report

Project No.: 16985

#### Introduction

The South Cooper Mountain Heights subdivision project is a proposed residential development in the City of Beaverton, with stormwater jurisdiction through Clean Water Services (CWS). The development will consist of 110 attached single-family lots, 271 detached single-family lots, and one parcel for future multi-family residential development. The development also includes sidewalks, public roadways, private driveways, utilities, and a stormwater management system. The stormwater management system will include a conveyance system, Low Impact Development Approach (LIDA) water quality facilities, and ten regional stormwater management facilities.

The purpose of this memorandum is to outline compliances of the South Cooper Mountain Heights stormwater management system with the U.S. Army Corps of Engineers SLOPES V for Stormwater, Transportation and Utilities (USACOE, 2014), the City of Beaverton (COB) Engineering Design Manual (COB, 2007) and the Clean Water Services Design and Construction Standards for Sanitary Sewer and Surface Water Management (CWS, 2007). Descriptions of the pre-development and proposed hydrologic conditions as well as preliminary documentation showing the onsite stormwater management system's compliance with SLOPES V and COB standards for water quality and quantity are included in this report.

## Design Criteria

Design of the proposed stormwater system will meet the following design criteria:

- SLOPES V for Stormwater, Transportation and Utilities (USACOE, 2014)
- Design and Construction Standards for Sanitary Sewer and Surface Water Management (CWS, 2007)
- Engineering Design Manual (COB, 2007)
- Low Impact Development Approaches Handbook (CWS, 2009)

The City of Beaverton has adopted the CWS Design and Construction Standards for Sanitary Sewer and Surface Water Management. All City standards in the Engineering Design Manual meet or exceed the CWS stormwater requirements. Additionally, the City of Beaverton is in the process of updating their Engineering Design Manual, and any changes to the Engineering Design Manual may apply to the South Cooper Mountain Heights subdivision project. The City of Beaverton's anticipated design standards will meet or exceed the current COB standards, and therefore were considered in this stormwater analysis.

#### **Project Phasing**

The South Cooper Mountain Heights subdivision project will be constructed in five phases, as shown in Figures 2A through 2D. Water quality and detention facilities for Phase 1 and the improvements along SW 175<sup>th</sup> Avenue were sized using SLOPES V standards. This phase is anticipated to be developed prior to the release of the City of Beaverton's updated stormwater standards.

Phases 2 through 5 are anticipated to be developed after the City's adoption of updated stormwater standards, thus triggering the need to use different sizing methodology. Combined water quality and quantity facilities within Phases 2 through 5 were sized using current COB standards. The required volume of these facilities was then multiplied by of a factor of 2.5 to estimate pond sizes in anticipation of future, more stringent standards. This increased volume factor was based on Otak internal discussions regarding preliminary results from facility sizing using the Tualatin River Urban Stormwater Tool (TRUST) software to aid in the design of water quantity control facilities based on a continuous flow duration model. Preliminary results from use of the TRUST software on the River Terrace subdivision, which is located directly south of the South Cooper Mountain Heights subdivision, required detention ponds with approximately 2.5 times the volume of detention ponds sized using the current CWS peak matching methodology. It is anticipated that the City of Beaverton will adopt a continuous flow duration model for sizing of stormwater facilities, therefore, the factor of 2.5 was used to estimate the volume needed for the ponds in Phases 2 through 5 of the development. Continuous flow duration modeling for the sizing of facilities would also meet SLOPES V stormwater standards for the project site.

## Site Description

#### Location

The proposed South Cooper Mountain Heights development is located in the City of Beaverton, Oregon. The development site is bordered to the south by SW Scholls Ferry Road and to the west by SW 175<sup>th</sup> Avenue (see Vicinity Map). The western portion of the site is currently being used for agriculture, while the eastern portion of the site is an undeveloped mixture of grass and wooded areas.



Vicinity Map

#### Topography

The South Cooper Mountain Heights project will be constructed on land with slopes ranging from 1.5 to 14 percent. An unnamed drainage ditch intersects the property in the northeast corner. There is also another unnamed drainage ditch that runs from north to south across the property with significant wetland area located in the southern portion of the project site, as shown Figure 1B. Existing elevations on the property vary between approximately 310 feet in the southeast corner to 460 feet on the northern property boundary.

#### Soils

Soils are categorized by the National Resource Conservation Service (NRCS) as hydrologic soil group types C and D, which consist of silt loams (See Appendix A). These soils generally exhibit moderate to low infiltration rates and relatively high runoff rates. Type C soils are located generally within the areas of proposed development, while Type D soils are shown to be located in stream and wetland corridors.

## Drainage Basins

#### **Existing Conditions**

Stormwater runoff generally drains from the northwest to the southeast toward SW Scholls Ferry Road. See Figures 1A and 1B for onsite drainage basins under existing conditions. The 107.7 acre South Cooper Mountain Heights project is located within the Fanno Creek Subbasin, which is within the Tualatin River Basin.

Preliminary Drainage Report

#### **Proposed Conditions**

The proposed development will consist of 110 attached single-family lots, 271 detached single-family lots and one parcel for future multi-family residential development. Per COB and CWS standards, a maximum impervious area of 2,640 square feet was assumed for each detached single-family residential lot within the project limits. For attached single-family residential lots and multi-family buildings, impervious rooftop areas were calculated using building footprints. The project will add approximately 47.26 acres of new impervious area, including rooftops, roadways, sidewalks, and driveways.

Under proposed conditions, the site was divided into ten drainage basins, one of which includes public right of way. See Figures 2A through 2D for onsite drainage basins under proposed conditions. Stormwater runoff within each onsite basin (Basins M, N, O, P1, P2, P3, P4, P5, and Q1) will have a stormwater management pond to meet water quality and water quantity requirements. Runoff generated by a portion of SW 175<sup>th</sup> Avenue (Basin Q2) will be treated by LIDA facilities and detained in a detention pond located within the property limits of the South Cooper Mountain Heights subdivision. See Table 1 for a summary of the basin areas under predevelopment and proposed conditions.

	Table I: Basin Areas							
		Pre-develo	opment Condit	ions	Pro	Proposed Conditions		
Basin	Phase	Impervious Area (ac)	Pervious Area (ac)	Total Area (ac)	Pervious Area (ac)	Impervious Area (ac)	Total Area (ac)	
M	Phase 2	0.00	34.27	34.27	17.48	16.79	34.27	
N	Phase 2	0.00	2.74	2.74	1.18	1.56	2.74	
О	Phase 3	0.00	5.52	5.52	2.25	3.27	5.52	
P1	Phase 1	0.00	5.82	5.82	2.43	3.39	5.82	
P2	Phase 1	0.00	0.93	0.93	0.35	0.58	0.93	
Р3	Phase 1	0.00	8.64	8.64	2.81	5.83	8.64	
P4	Phase 1	0.00	4.07	4.07	1.15	2.92	4.07	
P5	Phase 4	0.00	5.29	5.29	1.50	3.78	5.29	
Q1	Phase 5	0.00	10.23	10.23	4.50	5.73	10.23	
Q2	Phase 1	0.00	3.40	3.40	0.00	3.40	3.40	
Total		0.00	80.91	80.91	33.65	47.26	80.91	

## Hydrology

For this preliminary analysis, the proposed development was divided into pervious and impervious areas within each drainage basin, as shown above in Table 1. Peak runoff rates generated from each development phase were calculated using the Santa Barbara Urban Hydrograph (SBUH) method in HydroCAD v10.0. Precipitation depths for this project site, listed in Table 2, were obtained from the COB Engineering Design Manual. These depths were determined to be more conservative than both the CWS and NOAA precipitation depths, and were therefore used to calculate site rainfall and runoff rates based on the NRCS Type 1A rainfall distribution.

Table 2: City of Beaverton Precipitation Depths				
Recurrence Interval	Precipitation Depth (in)			
2-Year	2.50			
10-Year	3.50			
25-Year	4.00			
100-Year	4.50			

#### Curve Number

Curve Numbers (CN) for impervious and pervious areas during pre-development, existing and proposed conditions were selected using Table 2-2a – Runoff Curve Numbers for Urban Areas from Technical Release 55: Urban Hydrology for Small Watersheds (TR-55) (See Appendix A). SLOPES V standards require release rates from detention facilities to match pre-development discharge rates. As such, Phase 1 of project site is to be modeled using CNs under pre-development conditions (the site's natural groundcover and grade before any development occurred). According to the Bureau of Land Management's Cadastral Survey, the appropriate pre-development condition for the site is Woods. COB standards require release rates from detention facilities to match existing discharge rates. As such, Phases 2 through 5 were modeled using CNs based on the current, existing conditions at the project site. Table 3 provides a summary of the runoff curve numbers under pre-development, existing and proposed conditions.

Preliminary Drainage Report

	Table 3: Runoff Curve Number	^S	
Category	Cover Type	Hydrologic Soil Group	Curve Number
Impervious Area	Pavement, roofs, sidewalks	С	98
Pervious Area, Pre-development Conditions	Woods - Good Condition	С	70
Pervious Area, Existing Conditions	Woods/grass combination - Good Condition	С	72
Pervious Area, Existing Conditions	Pasture, grassland or range - Good Condition	С	74
Pervious Area, Proposed Conditions	50-75% Grass cover - Fair Condition	С	79

#### Time of Concentration

The time of concentration (Tc) represents the maximum time needed for all areas of the basin to contribute to the outflow hydrograph. Time of concentration values for each contributing drainage basin during pre-development, existing and proposed conditions were calculated using the method provided by the SCS Technical Release 55 (SCS, 1986) (see Appendix A). A time of concentration of five minutes, the minimum allowable, was assumed for all proposed conditions as a conservative design approach.

## Water Quality

Per the Oregon Department of Environmental Quality (DEQ) Stormwater Management Plan Submission Guidelines for Removal/Fill Permit Applications, the pollutants of concern for a commercial/residential development are as follows:

- Nutrients
- Pesticides, Herbicides, Fungicides
- Metals (Zinc, Copper, Lead, etc.)
- Oil, Grease & Other Petroleum
- Sediment

The water quality volume for compliance with SLOPES V standards is determined by multiplying 50 percent of the 2-year, 24-hour precipitation depth by the entire contributing impervious area for each drainage basin. COB standards require water quality treatment for runoff from contributing impervious areas in each drainage basin generated by 0.36 inches of precipitation falling in a 4-hour period. For all onsite basins (M, N, O, P1, P2, P3, P4, P5, and Q1), water quality treatment will be provided be the regional stormwater management facilities.

December 2, 2015

Stormwater facilities in Phase 1 (P1, P2, P3 and P4) have been sized to treat the water quality volume for compliance with SLOPES V standards. Stormwater facilities in Phases 2 through 5 (M, N, O, P5, Q1) have been sized using COB standards. Each facility has an orifice sized to detain the water quality volume and release it over a 48-hour period. See Appendix B for water quality treatment sizing calculations for the onsite extended dry basins.

Basin Q2 consists of the contributing impervious area from SW 175<sup>th</sup> Avenue. Water quality treatment for runoff within Basin Q2 will be provided by LIDA swales in the planter strip. A simplified approach method was used to size the LIDA facilities in Basin Q2, with each LIDA facility required to have a minimum treatment area equal to six percent of the contributing impervious area, per CWS standards. LIDA sizing will be included in the design of the SW 175<sup>th</sup> Avenue public improvements.

## Water Quantity

#### SLOPES V Detention Standards (Phase I)

SLOPES V standards require flow duration matching for storm event frequencies between 50 percent of the 2-year storm event through the 10-year storm event. Flow duration matching requires a continuous simulation hydrologic model; a type of modeling which has not yet been adopted by CWS or the City of Beaverton. In the absence of an adopted continuous simulation model, a target peak flow matching method was used to approximate the results of the flow duration standard. The target peak flow matching is as follows:

- Limit the peak rate from 50% of the 2-year, 24-hour design storm to the pre-developed condition peak rate from 50% of the 2-year, 24-hour design storm.
- Limit the peak rate from the 2-year, 24-hour design storm to the pre-developed condition peak rate from the 2-year, 24-hour design storm.
- Limit the peak rate from the 10-year, 24-hour design storm to the pre-developed condition peak rate from the 10-year, 24-hour design storm.
- Limit the peak rate from the 25-year, 24-hour design storm to the pre-developed condition peak rate from the 25-year, 24-hour design storm.

Stormwater facilities in Phase 1 (P1, P2, P3, P4 and Q2) have been sized to meet detention requirements for compliance with SLOPES V standards using HydroCAD v10.0 software (see Appendix C). Table 4 provides the pre-development peak runoff rates and the detained peak discharge rates under proposed conditions for each basin within Phase 1 of the South Cooper Mountain Heights project site. Table 5 contains the sizing parameters for the five proposed extended dry basins in Phase 1.

Preliminary Drainage Report

Table 4: Phase I Facility Flow Control Summary									
		Peak Flow Rate (cfs)							
	50%	50% of 2-year		2-year		10-year		25-year	
Catchment/ Facility ID	Predev	Proposed (Detained)	Predev	Proposed (Detained)	Predev	Proposed (Detained)	Predev	Proposed (Detained)	
Basin P1	0.09	0.09	0.17	0.17	0.54	0.54	0.81	0.76	
Basin P2	0.02	0.01	0.03	0.02	0.14	0.09	0.20	0.11	
Basin P3	0.13	0.13	0.25	0.25	0.87	0.87	1.31	1.16	
Basin P4	0.06	0.06	0.12	0.11	0.38	0.36	0.57	0.48	
Basin Q2	0.05	0.05	0.10	0.10	0.31	0.31	0.46	0.45	

Table 5: Phase I Extended Dry Detention Basin Design Parameters					
		SLOPES V Standards			
Basin	Phase	Top Surface Area (sf)	Active Volume (cf)	Total Depth (ft)	
P1	Phase 1	9,636	32,467	7	
P2	Phase 1	2,983	6,196	7	
Р3	Phase 1	13,695	50,594	7	
P4	Phase 1	8,160	26,025	7	
Q2	Phase 1	8,820	28,836	7	

#### COB Detention Standards (Phases 2-5)

The City of Beaverton Engineering Design Manual requires that detention be provided for all development on sites greater than or equal to one-half acre in size. The mitigated peak discharge rate released by each regional stormwater management facility must be less than or equal to the peak flow rate from the respective existing conditions 2-year, 10-year and 25-year recurrence interval storm events generated by the corresponding contributing basin, per COB standards. Phases 2 through 5 of the development will meet detention requirements through the use of five onsite extended dry basins. These facilities were sized using HydroCAD v10.0 software (see Appendix C). Because the site will be developed in multiple phases, the stormwater management facilities for Phases 2 through 5 were upsized to manage a storage volume 2.5 times greater than a facility designed using current COB standards in anticipation of future COB stormwater management standards. This sizing methodology was used to approximate the results of a using a continuous simulation model for sizing of detention facilities. Since SLOPES V requirements call for the use of continuous simulation modeling for sizing of detention facilities, it is assumed that the facilities sized for Phases 2 through 5 will also be in compliance with SLOPES V requirements.

Table 6 provides existing peak runoff rates and detained peak discharge rates under proposed conditions for each basin in Phases 2 through 5 of the South Cooper Mountain Heights project site. Table 7 contains the sizing parameters for the five proposed extended dry basins in Phases 2 through 5 of the development.

Table 6: Phases 2-5 Facility Flow Control Summary							
		Peak Flow Rate (cfs)					
	2-у	2-year		10-year		25-year	
Catchment/Facility ID	Existing	Proposed (Detained)	Existing	Proposed (Detained)	Existing	Proposed (Detained)	
Basin M	1.46	1.44	5.23	4.22	7.59	6.24	
Basin N	0.12	0.10	0.43	0.31	0.62	0.48	
Basin O	0.22	0.21	0.72	0.69	1.04	1.02	
Basin P5	0.33	0.32	1.02	0.84	1.42	1.39	
Basin Q1	0.56	0.53	1.67	1.46	2.35	2.33	

	Table 7: Phases 2-5 Extended Dry Detention Basin Design Parameters							
			COB Standards		Anticipated Future COB Standards			
Basin	Phase	Top Surface Area (sf)	Active Volume (cf)	Total Depth (ft)	Top Surface Area (sf)	Active Volume (cf)	Total Depth (ft)	
M	Phase 2	41,148	133,633	5	65,100	346,284	7	
N	Phase 2	6,327	14,724	5	9,360	41,022	7	
О	Phase 3	9,936	26,532	5	15,075	70,538	7	
P5	Phase 4	9,792	25,416	5	14,850	69,363	7	
Q1	Phase 5	13,983	39,012	5	21,500	104,669	7	

## Conveyance

Preliminary pipe layouts are shown in the construction plan sets (to be provided in final Stormwater Management Plan document). Inlets, manholes and pipes were located based on COB design criteria and the proposed layout of parking lots, roadways, and buildings. During final design, the stormwater conveyance network will be sized using the 25-year, 24-hour storm event with the condition that the hydraulic grade line remains at least 1 foot below the rim elevations at manholes and catch basins. Storm outfalls will be armored to protect channel banks.

Preliminary Drainage Report

#### Operations and Maintenance

An Operations and Maintenance Plan will be compiled during final design for the use of the private property owner and responsible party. The plan will identify the responsible party, describe the stormwater management system, provide information on inspecting and maintaining the extended dry basins, LIDA flow-through planters, and the water quality and flow control manholes, and include inspection logs. The inspection log will be kept onsite and available for audit. In accordance with SLOPES V standards, inspection and maintenance will be required at least quarterly for the first three years, at least twice per year thereafter, and within 48 hours of a storm event greater than or equal to 1.0 inch of rain during a 24-hour period. The Operations and Maintenance Plan will be included with the Final Stormwater Management Plan.

#### Conclusions

The proposed South Cooper Mountain Heights development project will include a stormwater management system designed to meet the requirements of SLOPES V and the City of Beaverton. The development will create approximately 47.26 acres of new impervious area. Combined water quality and water quantity facilities designed for Phase 1 will meet SLOPES V standards. For Phases 2 through 5, the stormwater management facility volumes calculated using current COB standards and then were upsized in anticipation of future stormwater management standards. The facilities sized using this methodology are assumed to meet SLOPES V standards as the volume sizing factor of 2.5 is meant to approximate the results of continuous simulation modeling. For the public right-of-way, LIDA facilities will be designed to provide water quality treatment for runoff generated by SW 175<sup>th</sup> Avenue. SLOPES V water quantity requirements will be met by a detention pond located within the project limits of the South Cooper Mountain Heights site. The onsite conveyance system will be sized during the final design phase using standards set by the City of Beaverton.

December 2, 2015

#### References

- COB, 2007. City of Beaverton Engineering Design Manual and Standard Drawings, City of Beaverton, January 2007.
- CWS, 2007. Design and Construction Standards for Sanitary Sewer and Surface Water Management, Clean Water Services, June 2007.
- CWS, 2009. Low Impact Development Approaches Handbook, Clean Water Services, July 2009.
- HHPR, 2015. South Cooper Mountain High School Draft Stormwater Management Report, Harper Houf Peterson Righellis, Inc., January, 2015.
- SCS, 1986. Technical Release 55: Urban Hydrology for Small Watersheds, United States Department of Agriculture Soil Conservation Service, June 1986.
- USACE, 2014. SLOPES V for Stormwater, Transportation or Utilities, United States Army Corps of Engineers, March 14, 2014.

Figures

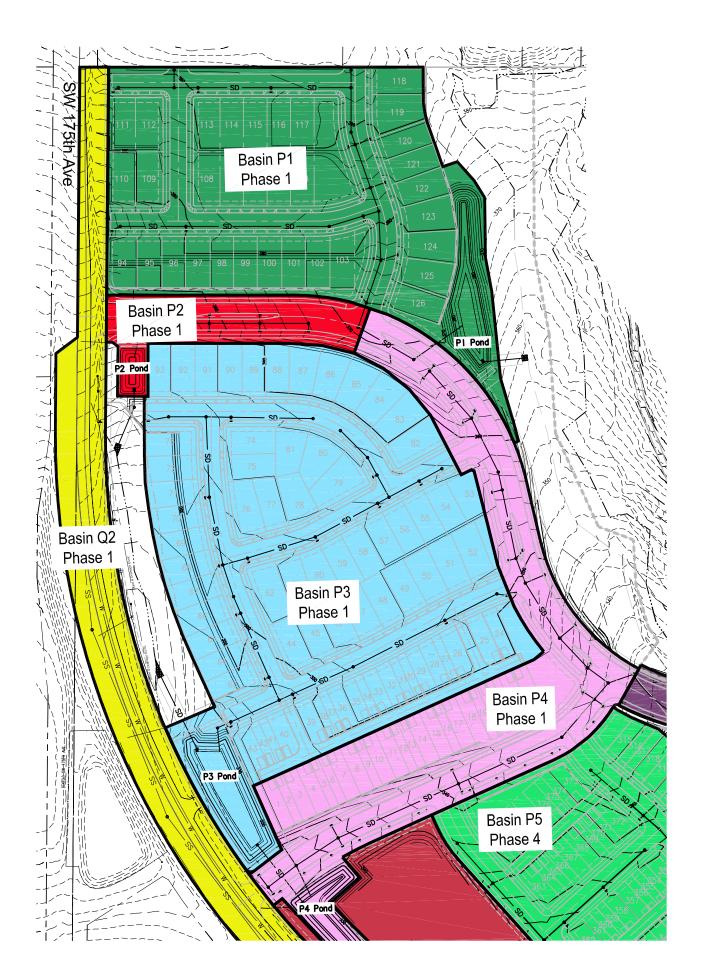


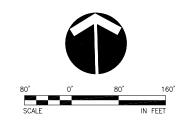
Resclved
P17531X101
017531X101
S17531X190
S17531X104
017531X104
017531X106 TAXLOT BOUNDARY WEST HILLS

DEVELOPMENT, INC.
735 SW 158TH AVENUE
BEAVERTON, OR 97006 251 06 TL 103 54. I AC HEIGHTS 2S 06 TL 200 53.62 A& MOUNTAIN SOUTH COOPER BEAVERTON, OREGON EXISTING CONDITIONS NORTH LEGEND STORM DRAIN LINE STORM DRAIN MANHOLE CONTOUR LINE WETLAND LIMIT otak CWS VEGETATED CORRIDOR **Hanmi**Global Partner 808 SW 3rd Ave., Ste. 300 Portland, OR 97204 Phone: (503) 287-6825 Fax: (503) 4:5-2304 www.otak.com 100 YEAR FLOOD PLAIN DRAINAGE ARROW 16985
Project No. Drawing No.
Figure 1A

Resclved
P17531X101
017531X101
S17531X190
S17531X104
017531X104
017531X106 2ST 06 TL 200 53.62 AC 2S 06 TL 103 54. IL AC WEST HILLS

DEVELOPMENT, INC.
735 SW 158TH AVENUE
BEAVERTON, OR 97006 -PROPERTY BOUNDARY 251 06 TL 205 HEIGHTS MOUNTAIN S.W. BARROWS 2\$1\_06 FL\_200 0.16\_AC 281 06 Tk 200 2SI 06 SOUTH COOPER BEAVERTON, OREGON TL 200 0.78 AC EXISTING CONDITIONS SOUTH 0.19 AC LEGEND STORM DRAIN LINE STORM DRAIN MANHOLE CONTOUR LINE WETLAND LIMIT otak CWS VEGETATED CORRIDOR HanmiGlobal Partner 808 SW 3rd Ave., See. 300 Portland, OR 97204 Phone: (503) 287-6825 Fax: (503) 4:5-2304 www.otak.com 100 YEAR FLOOD PLAIN DRAINAGE ARROW 16985 Project No. Drawing No. Figure 1B





LEGEND	
STORM LINE	SD
STORM CURB INLET/CATCH BASIN	N =
STORM MANHOLE	•
PUBLIC UTILITY EASEMENT	
DRAINAGE BASIN	
WETLAND LIMIT	
CWS VEGETATED CORRIDOR	

SOUTH COOPER MOUNTAIN HEIGHTS BEAVERTON, OREGON



808 SW 3rd Ave., Ste. 300 Portland, OR 97204 Phone: (503) 287-6825 Fax: (503) 415-2304 www.otak.com

PROPOSED CONDITIONS NORTHWEST

Project No. Drawing No. Figure 2A

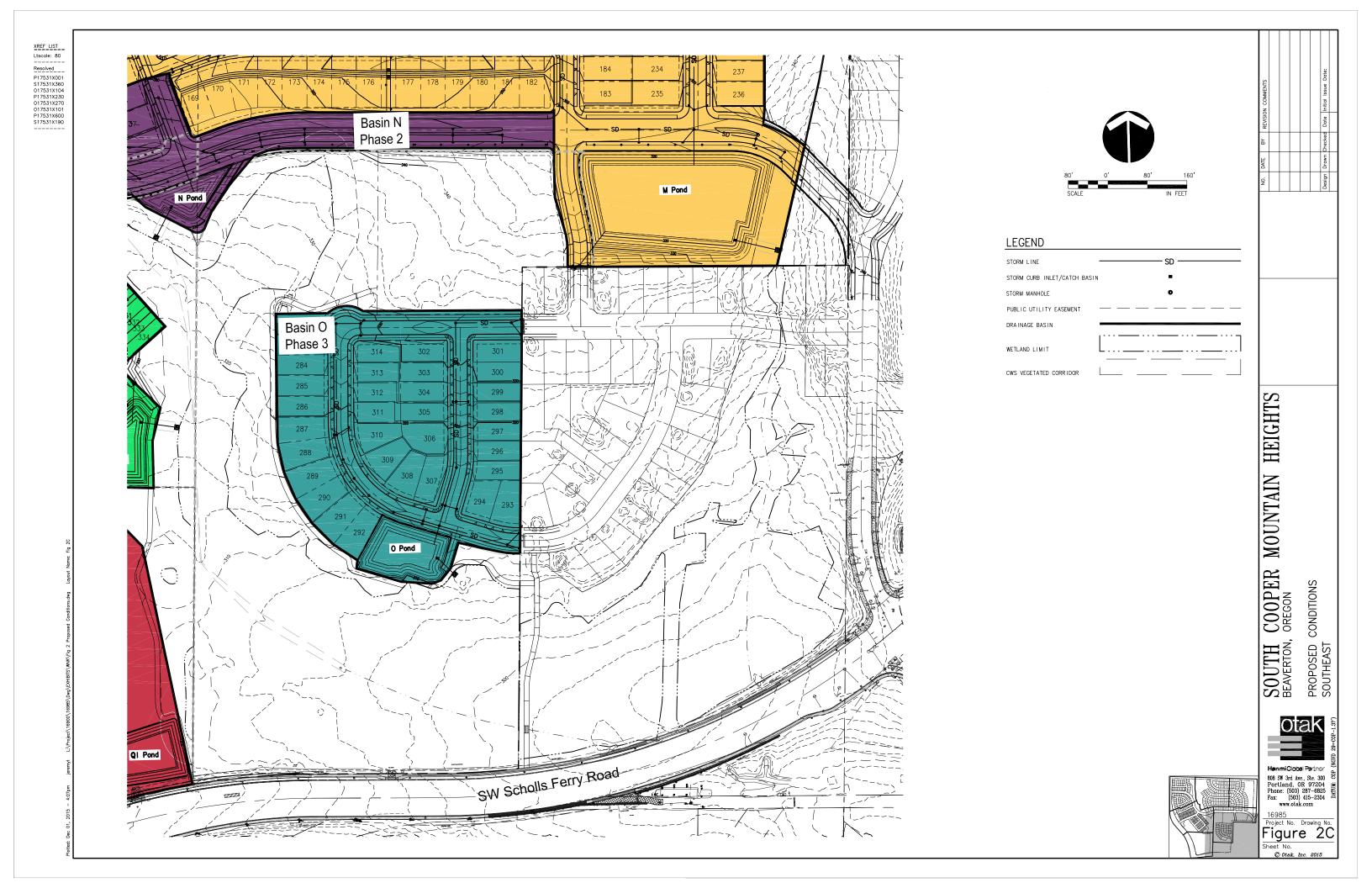
XREF\_LIST Ltscale: 80 Resolved
P17531X001
S17531X360
017531X104
P17531X230
017531X270
017531X101
P17531X600
S17531X190 254 255 383 256 LEGEND STORM LINE STORM CURB INLET/CATCH BASIN STORM MANHOLE PUBLIC UTILITY EASEMENT Basin M DRAINAGE BASIN Phase 2 WETLAND LIMIT CWS VEGETATED CORRIDOR 230 241 231 186 232 239 233 238 184 234 237 235 Basin N Phase 2 M Pond N Pond Basin O

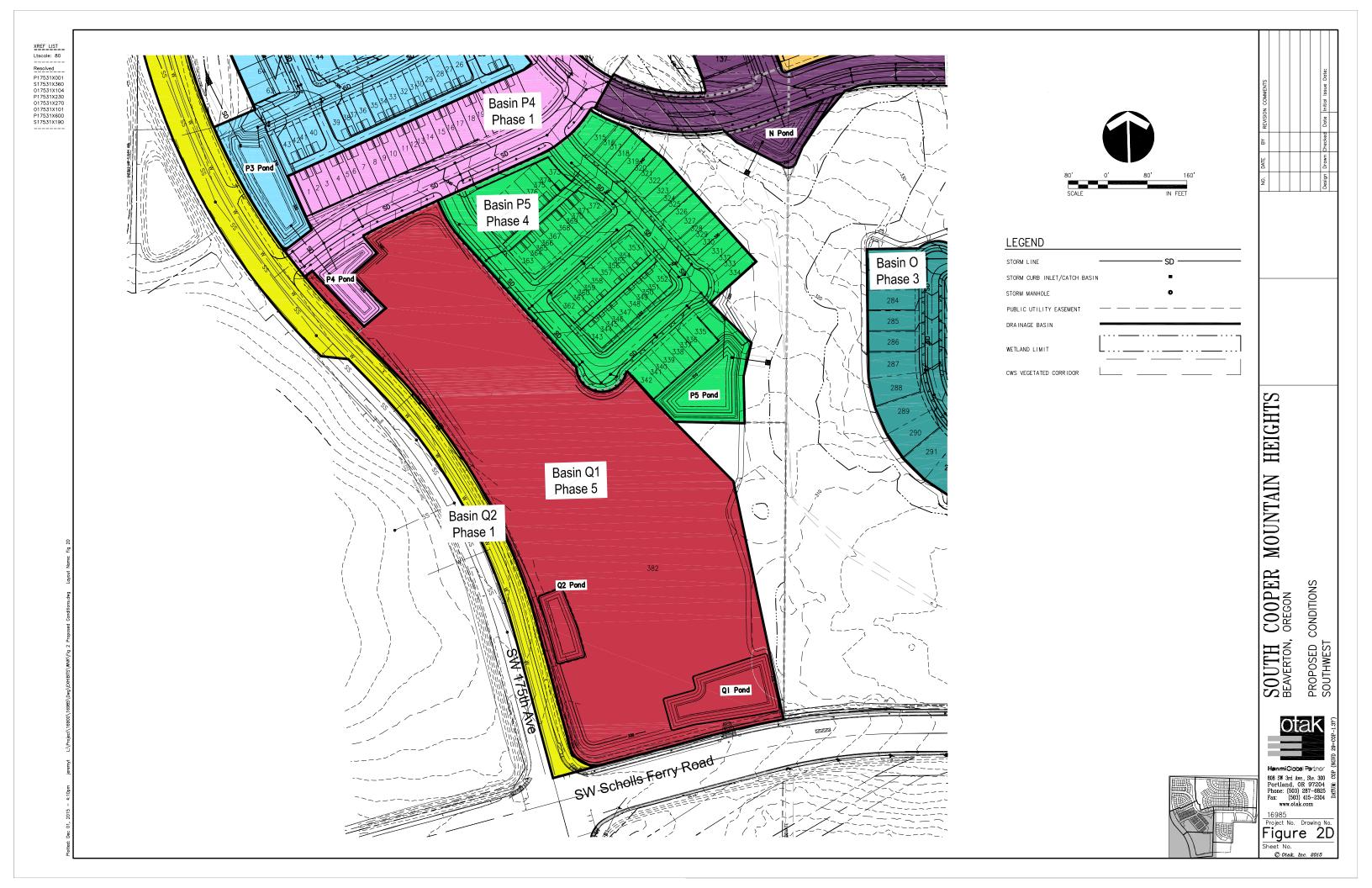
HEIGHTS SOUTH COOPER MOUNTAIN BEAVERTON, OREGON

PROPOSED CONDITIONS NORTHEAST

808 SW 3rd Ave., Ste. 300 Portland, OR 97204 Phone: (503) 287-6825 Fax: (503) 415-2304 www.otak.com

Project No. Drawing No. Figure 2B





Appendix A—Site Hydrologic Information





# MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting Enlargement of maps beyond the scale of mapping can cause soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements

Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov Source of Map: Natural Resources Conservation Service Coordinate System: Web Mercator (EPSG:3857)

Albers equal-area conic projection, should be used if more accurate distance and area. A projection that preserves area, such as the Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts calculations of distance or area are required. This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

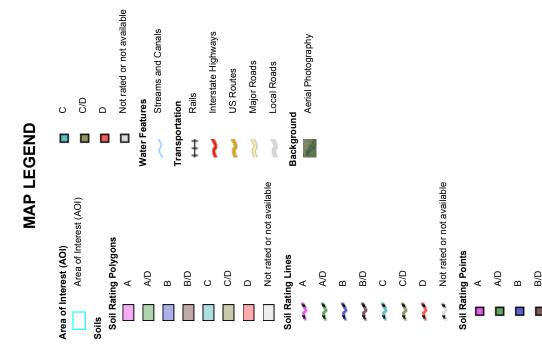
Soil Survey Area: Washington County, Oregon

Survey Area Data: Version 12, Sep 19, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 8, 2010—Aug 23,

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident. The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background



# **Hydrologic Soil Group**

Hydrologic Soil Group— Summary by Map Unit — Washington County, Oregon (OR067)					
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI	
7B	Cascade silt loam, 3 to 7 percent slopes	С	0.2	0.1%	
7C	Cascade silt loam, 7 to 12 percent slopes	С	27.4	15.3%	
11B	Cornelius and Kinton silt loams, 2 to 7 percent slopes	С	50.3	28.1%	
11C	Cornelius and Kinton silt loams, 7 to 12 percent slopes	_	27.8	15.5%	
11D	Cornelius and Kinton silt loams, 12 to 20 percent slopes	С	26.9	15.0%	
11E	Cornelius and Kinton silt loams, 20 to 30 percent slopes	С	6.1	3.4%	
16C	Delena silt loam, 3 to 12 percent slopes	D	40.3	22.5%	
Totals for Area of Inte	rest		179.0	100.0%	

### **Description**

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

## **Rating Options**

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Chapter 2	Estimating Runoff	Technical Release 55
		Urban Hydrology for Small Watersheds

# **Existing Conditions**

**Table 2-2c** Runoff curve numbers for other agricultural lands V

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	В		
	Doom	co.	70	0.0	00
Pasture, grassland, or range—continuous	Poor Fair	68 49	79 69	86 79	89 84
forage for grazing. 2/	Good	49 39	61	79 74 <b>←</b>	80
	5.555				
Meadow—continuous grass, protected from grazing and generally mowed for hay.	_	30	58	71	78
Brush—brush-weed-grass mixture with brush	Poor	48	67	77	83
the major element. 3/	Fair	35	56	70	77
·	Good	30 4/	48	65	73
Woods—grass combination (orchard	Poor	57	73	82	86
or tree farm). 5/	Fair	43	65	76	82
,	Good	32	58	72 ←	79
Woods. 6/	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 4/	55	70 ←	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	_	59	74	82	86

<sup>&</sup>lt;sup>1</sup> Average runoff condition, and  $I_a = 0.2S$ .

<sup>2</sup> *Poor:* <50%) ground cover or heavily grazed with no mulch.

Fair: 50 to 75% ground cover and not heavily grazed.

Good: > 75% ground cover and lightly or only occasionally grazed.

<sup>&</sup>lt;sup>3</sup> *Poor*: <50% ground cover.

Fair: 50 to 75% ground cover.

Good: >75% ground cover.

 $<sup>^4</sup>$  Actual curve number is less than 30; use CN = 30 for runoff computations.

<sup>&</sup>lt;sup>5</sup> CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

<sup>6</sup> Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.

Fair: Woods are grazed but not burned, and some forest litter covers the soil.

Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Chapter 2	Estimating Runoff	Technical Release 55
		Urban Hydrology for Small Watersheds

## **Proposed Conditions**

**Table 2-2a** Runoff curve numbers for urban areas 1/

Cover description				umbers for soil group	
	verage percent		<b>V</b>	0 - 1	
	pervious area 2/	A	В	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) 3/:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79 🖊	- 84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc.					
(excluding right-of-way)		98	98	98 🕶	- 98
Streets and roads:	•••	00	00	00	00
Paved; curbs and storm sewers (excluding					
right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:	••	12	02	01	00
Natural desert landscaping (pervious areas only) 4		63	77	85	88
Artificial desert landscaping (impervious weed barrier,	••	09	• •	00	00
desert shrub with 1- to 2-inch sand or gravel mulch					
and basin borders)		96	96	96	96
Urban districts:	••	00	00	00	00
Commercial and business	85	89	92	94	95
Industrial		81	88	91	93
Residential districts by average lot size:	12	01	00	31	99
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre		61	75	83	87
1/3 acre		57	72	81	86
1/2 acre		54	70	80	85
1 acre		5 <del>1</del>	68	79	84
2 acres		46	65	79 77	82
2 acres	14	40	UU	11	04
Developing urban areas					
Newly graded areas					
(pervious areas only, no vegetation) 5/		77	86	91	94
Idle lands (CN's are determined using cover types					
similar to those in table 2-2c).					

 $<sup>^{\</sup>rm 1}$  Average runoff condition, and  $I_a$  = 0.2S.

<sup>&</sup>lt;sup>2</sup> The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

<sup>3</sup> CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

<sup>&</sup>lt;sup>4</sup> Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

<sup>&</sup>lt;sup>5</sup> Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.



# **Time of Concentration Calculations**

Project Name: South Cooper Mountain		By: TSC, JCT	Date: 11/30/2015	
Project Number: 16985				
		Basin M	Basin N	Basin O
DACINI				
BASIN	011555	Existing	Existing	Existing
IN IOU IT	SHEE	FLOW		
INPUT			1	
Surface Description (from Table 3-1)		Grass: Dense	Grass: Dense	Grass: Dense
Manning's Roughness Coefficient		0.24	0.24	0.24
Flow Length , L (<300 ft)	ft	300	265	300
2-Year, 24-Hour Rainfall, P <sub>2</sub>	in	2.5	2.5	2.5
Land Slope, s	ft/ft	0.130	0.090	0.040
OUTPUT				
Travel Time	hr	0.31	0.32	0.49
SHALLOV	v conc	ENTRATED FL	ow	
INPUT				
Surface Description (paved or unpaved)		Unpaved	-	Unpaved
Flow Length, L	ft	816	-	190
Watercourse Slope, s	ft/ft	0.130	-	0.049
OUTPUT				
Average Velocity, V	ft/s	5.82	-	3.57
Travel Time	hr	0.039	-	0.015
1	CHANN	EL FLOW	1	
INPUT				
Cross Sectional Flow Area, a	ft <sup>2</sup>	-	-	-
Wetted Perimeter, p <sub>w</sub>	ft	-	-	-
Channel Slope, s	ft/ft	-	-	-
Manning's Roughness Coefficient		-	-	-
Flow Length, L	ft	-	-	-
OUTPUT			1	
Average Velocity, V	ft/s	-	-	-
Hydraulic Radius, r = a/p <sub>w</sub>	ft	-	-	-
Travel Time	hr	-	-	-
Basin Time of Concentration, T <sub>c</sub>	hrs	0.35	0.32	0.51
	min	20.7	19.3	30.4



# **Time of Concentration Calculations**

Project Name: South Cooper Mountain		By: TSC, JCT	Date: 11/30/2015	
Project Number: 16985				
BASIN		Basin PI Predev	Basin P2 Predev	Basin P3 Predev
	SHEET	FLOW		
INPUT				
Surface Description (from Table 3-1)		Woods	Woods	Woods
Manning's Roughness Coefficient		0.4	0.4	0.4
Flow Length , L (<300 ft)	ft	300	83	300
2-Year, 24-Hour Rainfall, P <sub>2</sub>	in	2.5	2.5	2.5
Land Slope, s	ft/ft	0.050	0.070	0.080
OUTPUT			•	•
Travel Time	hr	0.68	0.21	0.56
SHALLOV	v conc	ENTRATED F	LOW	
INPUT				
Surface Description (paved or unpaved)		Unpaved	-	Unpaved
Flow Length, L	ft	205	-	226
Watercourse Slope, s	ft/ft	0.050	-	0.080
OUTPUT			-	-
Average Velocity, V	ft/s	3.61	-	4.56
Travel Time	hr	0.016	-	0.014
1	CHANN	EL FLOW		
INPUT				
Cross Sectional Flow Area, a	ft <sup>2</sup>	-	-	-
Wetted Perimeter, p <sub>w</sub>	ft	-	-	-
Channel Slope, s	ft/ft	-	-	-
Manning's Roughness Coefficient		-	-	-
Flow Length, L	ft	-	-	-
OUTPUT				
Average Velocity, V	ft/s	1		-
Hydraulic Radius, r = a/p <sub>w</sub>	ft	-	-	-
Travel Time	hr	-	-	-
Basin Time of Concentration, T <sub>c</sub>	hrs	0.69	0.21	0.57
	min	41.5	12.7	34.4



## **Time of Concentration Calculations**

Project Name: South Cooper Mountain		By: TSC, JCT	Date: 11/30/2015	
Project Number: 16985				
BASIN		Basin P4 Predev	Basin P5 Existing	Basin QI Existing
	SHEET	FLOW		
INPUT				
Surface Description (from Table 3-1)		Woods	Cultivated	Cultivated
Manning's Roughness Coefficient		0.4	0.17	0.17
Flow Length , L (<300 ft)	ft	300	300	300
2-Year, 24-Hour Rainfall, P <sub>2</sub>	in	2.5	2.5	2.5
Land Slope, s	ft/ft	0.050	0.080	0.030
OUTPUT	•			
Travel Time	hr	0.68	0.28	0.42
SHALLOV	V CONC	ENTRATED F	LOW	
INPUT				
Surface Description (paved or unpaved)		Unpaved	Unpaved	Unpaved
Flow Length, L	ft	111	306	424
Watercourse Slope, s	ft/ft	0.070	0.05	0.030
OUTPUT				
Average Velocity, V	ft/s	4.27	3.61	2.79
Travel Time	hr	0.007	0.024	0.042
	CHANN	EL FLOW		
INPUT				
Cross Sectional Flow Area, a	ft <sup>2</sup>	-	-	-
Wetted Perimeter, p <sub>w</sub>	ft	-	-	-
Channel Slope, s	ft/ft	-	-	-
Manning's Roughness Coefficient		-	-	-
Flow Length, L	ft	-	-	-
OUTPUT			•	
Average Velocity, V	ft/s	-	-	-
Hydraulic Radius, r = a/p <sub>w</sub>	ft	-	-	-
Travel Time	hr	-	-	-
Basin Time of Concentration, $T_c$	hrs	0.68	0.31	0.46
	min	41.0	18.4	27.6



## **Time of Concentration Calculations**

Project Name: South Cooper Mountain		By: TSC, JCT	Date: 11/30/2015	
Project Number: 16985		, ,		
•				
		Basin Q2		
BASIN		Predev		
	SHEET	Γ FLOW		
INPUT				
Surface Description (from Table 3-1)		Woods		
Manning's Roughness Coefficient		0.4		
Flow Length , L (<300 ft)	ft	300		
2-Year, 24-Hour Rainfall, P <sub>2</sub>	in	2.5		
Land Slope, s	ft/ft	0.050		
OUTPUT				
Travel Time	hr	0.68		
SHALLOV	V CONC	ENTRATED F	LOW	
INPUT				
Surface Description (paved or unpaved)		Unpaved		
Flow Length, L	ft	825		
Watercourse Slope, s	ft/ft	0.050		
OUTPUT		•	•	
Average Velocity, V	ft/s	3.61		
Travel Time	hr	0.064		
	CHANN	EL FLOW		
INPUT				
Cross Sectional Flow Area, a	ft <sup>2</sup>	-		
Wetted Perimeter, p <sub>w</sub>	ft	-		
Channel Slope, s	ft/ft	-		
Manning's Roughness Coefficient		-		
Flow Length, L	ft	-		
OUTPUT				
Average Velocity, V	ft/s	-		
Hydraulic Radius, $r = a/p_w$	ft	-		
Travel Time	hr	-		
Basin Time of Concentration, $T_c$	hrs	0.74		
	min	44.4		

Basin Areas 16985 South Coooper Mountain

Proposed Drainage Basins:

B			•					[	-	
				Impervious Area	sa sa		Pervious Area	Area	Total Area	۱rea
	Proposed									
	Single	Sidewalk	Roadway							
Basin Name	Family Units	(sf)	(sf)	Roof (sf)	Total (sf)	Total (ac)	(sf)	(ac)	(sf)	(ac)
Μ	161	060'29	239,431	425,040	731,561	16.79	761,328	17.48	1,492,889	34.27
Z	2	18,677	44,187	5,280	68,144	1.56	51,251	1.18	119,395	2.74
0	33	13,382	42,008	87,120	142,510	3.27	62,867	2.25	240,377	5.52
P1	34	11,699	46,077	89,760	147,536	3.39	106,023	2.43	253,559	5.82
Ъ2	0	4,937	20,297	0	25,234	85'0	15,274	0.35	40,508	0.93
P3	69	17,357	68,198	168,243	253,798	2.83	122,402	2.81	376,200	8.64
<b>b</b> 4	22	19,621	66,543	41,003	127,197	2.92	50,239	1.15	177,436	4.07
P5	09	13,302	42,725	108,839	164,866	3.78	65,554	1.50	230,420	5.29
Q1	0	0	126,450	123,364	249,814	5.73	195,963	4.50	445,777	10.23
<b>0</b> 2	0	15,016	133,041	0	148,057	3.40	0	0.00	148,057	3.40
TOTAL	381	181,111	828,957	1,048,649	2,058,717	47.26	1,465,901	33.65	3,524,618	80.91

Appendix B—Water Quality Calculations



Impervious Area:

Proposed Impervious 16.98 ac 739,481 ft²

EL = 273.95 TOP OF POND = 275

25-YR WSE

TOP OF WQV

0.4' PERMANENT POOL

# COB/CWS Standards

Water Quality Volume and Flow: WQV = 0.36 in x IA/12 in/ft WQF = WQV/14400

(4 hours) (CWS, 4.05.06) (CWS, 4.05.06)

Water Quality Volume Water Quality Flow 22,184 ft³ 1.54 ft³/s WQV

Current Pond: Bottom Width Bottom Length Side Slopes

173,20	Total Volume	
41,14	Top Area	3:1
	Total Depth	294 ft
28,51	Bottom Area	97 ft

rates (cfs)	1.46	5.23	7.59	10.16
Existing Conditions Peak Flowrates (cfs)	2-year	10-year	25-year	100-year
Existing C				

Proposed Conditions Peak Flowrates (cfs)	Peak Flov	vrates (cfs)
2	:-year	1.44
1(	10-year	4.22
2.	25-year	6.24
1(	100-year	9.57

	WQ Orifice Invert IE		Bottom of Pond		WQV			Max WSE	Top of Pond
Volume (cf)	0	0	0	285	23,574	61,837	96,454	133,633	173,446
Area (ac)	0.0001	0.0001	0.6547	0.6552	0.6983	0.7657	0.8237	0.8833	0.9446
Area (sf)	5.1984	5.1984	28,518	28,541	30,418	33,354	35,880	38,478	41,148
Depth (ft)	0.0	1.32	1.33	1.34	2.13	3.33	4.33	5.33	6.33
Elevation (ft)	29.86	66'66	100	100.01	100.8	102	103	104	105

WQ Orifice Sizing:  $D = 24 * [(Q/(C[2gH]^{0.5})/3.14]^{0.5}$ 

Water Quality Orifice Flow	Constant	Gravitational acceleration	From pond table above	Неад
0.13 ft³/s	0.62	32.2 ft/s <sup>2</sup>	2.13 ft	1.42 ft
~			NQ OR depth	

Water Quality Orifice Diameter

Impervious Area:

Proposed Impervious

1.56 ac 68,144 ft²

EL = 273.95

TOP OF POND = 275

25-YR WSE

TOP OF WQV

0.4' PERMANENT POOL

# COB/CWS Standards

Water Quality Volume and Flow: WQV = 0.36 in x IA/12 in/ft WQF = WQV/14400

(4 hours) (CWS, 4.05.06) (CWS, 4.05.06)

Water Quality Volume Water Quality Flow 2,044 ft³ 0.14 ft³/s WQV WQF

Current Pond: Bottom Width Bottom Length Side Slopes

Bottom Area Total Depth Top Area Total Volume 27 ft 81 ft 3 :1

owrates (cts)	0.10
ίF	2-year
Conditions Pear	
5	

	WQ Orifice Invert IE		Bottom of Pond		WQV			Max WSE	Top of Pond
Volume (cf)	0	0	0	22	2,244	5,778	9,819	14,724	20,565
Area (ac)	0.0001	0.0001	0.0502	0.0504	0.0643	0.0833	0.1023	0.1229	0.1452
Area (sf)	5.1984	5.1984	2,187	2,193	2,799	3,627	4,455	5,355	6,327
Depth (ft)	0.0	1.32	1.33	1.34	2.23	3.33	4.33	5.33	6.33
Elevation (ft)	98.67	66'66	100	100.01	100.9	102	103	104	105

WQ Orifice Sizing:  $D = 24 * [(Q/(C[2gH]^{0.5})/3.14]^{0.5}$ 

Ø	0.01 ft³/s	t³/s	Water Quality Orifice Flov
U	0.62		Constant
ρ.0	32.2 ft/s	t/s²	Gravitational acceleratior
WQ OR depth	2.23 ft		From pond table above
I	1.49 ft		Head

Water Quality Orifice Diameter

Impervious Area:

Proposed Impervious 3.27 ac 142,510 ft²

EL = 273.95

TOP OF POND = 275-

25-YR WSE

TOP OF WQV

COB/CWS Standards

(CWS, 4.05.06) (CWS, 4.05.06) Water Quality Volume and Flow: WQV = 0.36 in x IA/12 in/ft WQF = WQV/14400

(4 hours) Water Quality Volume 4,275 ft³ 0.30 ft³/s WQV

Water Quality Flow

Current Pond: Bottom Width Bottom Length Side Slopes

39 ft 117 ft 3 :1

Bottom Area Total Depth Top Area Total Volume

wrates (cfs)	0.21	0.69	1.02	1.60
ns Peak Flov	2-year	10-year	25-year	100-year
Proposed Conditions Peak Flowrates (cfs				

	WQ Orifice Invert IE		Bottom of Pond		WQV			Max WSE	Top of Pond
Volume (cf)	0	0	0	46	4,499	11,106	18,243	26,532	36,045
Area (ac)	0.0001	0.0001	0.1048	0.1050	0.1248	0.1510	0.1767	0.2039	0.2329
Area (sf)	5.1984	5.1984	4,563	4,572	5,435	6,579	7,695	8,883	10,143
Depth (ft)	0.0	1.32	1.33	1.34	2.23	3.33	4.33	5.33	6.33
Elevation (ft)	29.86	66'66	100	100.01	100.9	102	103	104	105

WQ Orifice Sizing:  $D = 24 * [(Q/(C[2gH]^{0.5})/3.14]^{0.5}$ 

Water Quality Orifice Flow	Constant	Gravitational acceleration	From pond table above	Head
0.02 ft³/s	0.62	32.2 ft/s <sup>2</sup>	2.23 ft	1.49 ft
~			NQ OR depth	

Water Quality Orifice Diameter

Impervious Area: IA

Proposed Impervious 3.39 ac 147,536 ft²

TOP OF POND = 275-

25-YR WSE

TOP OF WQV

	Water Quality Volume	Water Quality Flow
	14,754 ft³	1.02 ft³/s
SLOPES V Standards	WQV	WQF

wol				
Water Quality Flow	Bottom Area	Total Depth	Top Area	Total Volume
1.02 ft³/s	31 ft	90 ft	3:1	
WQF Current Pond:	Bottom Width	Bottom Length	Side Slopes	

rrates (cfs)	0.17	0.54	0.81	1.12
s Peak Flov	2-year	10-year	25-year	100-vear
Predevelopment Conditions Peak Flowrates (cfs				

Fs)	17	54	92	10
wrates (ci	0.17	0.!	0.76	1.3
Proposed Conditions Peak Flowrates (cfs)	2-year	10-year	25-year	100-year
Condition				
Proposed (				

	WQ Orifice Invert IE		Bottom of Pond					WQV			Max WSE	Top of Pond
Volume (cf)	0	0	0	28	3,171	7,175	12,014	15,070	17,791	24,586	32,467	41,506
Area (ac)	0.0001	0.0001	0.0640	0.0642	0.0815	0.1007	0.1215	0.1336	0.1439	0.1680	0.1938	0.2212
Area (sf)	5.1984	5.1984	2,790	2,797	3,552	4,386	5,292	5,821	6,270	7,320	8,442	9:96
Depth (ft)	0.0	1.32	1.33	1.34	2.33	3.33	4.33	4.88	5.33	6.33	7.33	8.33
Elevation (ft)	29.86	66'66	100	100.01	101	102	103	103.55	104	105	106	107

WQ Orifice Sizing:  $D = 24*[(Q/(C[2gH]^{\Lambda}0.5)/3.14]^{\Lambda}0.5$ 

Water Quality Orifice Flow	Constant	Gravitational acceleration	From pond table above	Неаф
0.09 ft <sup>3</sup> /s	0.62	32.2 ft/s <sup>2</sup>	4.88 ft	3.25 ft
			WQ OR depth	

Impervious Area: IA

Proposed Impervious 0.58 ac 25,234 ft²

TOP OF POND = 275---

25-YR WSE

TOP OF WQV

## SLOPES V Standards

Water Quality Volume	Water Quality Flow
2,523 ft³	0.18 ft³/s
WQV	WQF

30 30 30 30 30 30 30 30 30 30 30 30 30 3
1.1 Ton Area
19.5 ft Total Depth 7 ft
6.5 ft Bottom Area 127

Current Pond: Bottom Width Bottom Length Side Slopes

0.03	0.14	0.20	0.28
2-year	10-year	25-year	100-vear

(9	7	6	T	9
tes (cf	0.02	0.09	0.11	0.16
lowrat			_	эr
Proposed Conditions Peak Flowrates (cfs)	2-year	10-year	25-year	100-year
litions	(4		( 4	
Conc				
obose				
Ā				

	WQ Orifice Invert IE		Bottom of Pond					WQV			Max WSE	Top of Pond
Volume (cf)	0	0	0	1	223	673	1,424	2,533	2,547	4,113	6,196	8,867
Area (ac)	0.0001	0.0001	0.0029	0.0029	0.0073	0.0134	0.0211	0.0304	0.0305	0.0415	0.0541	0.0685
Area (sf)	5.1984	5.1984	127	128	319	583	919	1,322	1,327	1,807	2,359	2,983
Depth (ft)	0:0	1.32	1.33	1.34	2.33	3.33	4.33	5.32	5.33	6.33	7.33	8.33
Elevation (ft)	29.86	66'66	100	100.01	101	102	103	103.99	104	105	106	107

WQ Orifice Sizing:  $D = 24*[(Q/(C[2gH]^{\Lambda}0.5)/3.14]^{\Lambda}0.5$ 

Water Quality Orifice Flow	Constant	Gravitational acceleration	From pond table above	Head
0.01 ft³/s	0.62	32.2 ft/s <sup>2</sup>	5.32 ft	3.55 ft
ď	U	60	WQ OR depth	I

Water Quality Orifice Diameter

\*Minimum Orifice Diameter = 0.5 in

Impervious Area: IA

Proposed Impervious 5.83 ac 253,798 ft²

TOP OF POND = 275

25-YR WSE

TOP OF WQV

	Water Quality Volume Water Quality Flow
	25,380 ft³ 1.76 ft³/s
SLOPES V Standards	WQV WQF

2-year 10-year 25-year 100-year	
2-year   0.25   2-year   0.25   2-year   0.25   2-year   0.25   25-year   0.83   25-year   1.81   1.00.vear   1.81   1.00.vear   1.81	100

ates (cfs)	0.25	0.87	1.16	1.60
ons Peak Flowr	2-year	10-year	25-year	100-year
Proposed Conditions Peak Flowrates (cfs)				

	WQ Orifice Invert IE		Bottom of Pond					WQV			Max WSE	Top of Pond
Volume (cf)	0	0	0	09	2,553	12,162	19,899	25,565	28,832	39,041	50,594	£95'£9
Area (ac)	0.0001	0.0001	0.1158	0.1160	0.1392	0.1643	0.1910	0.2092	0.2194	0.2494	0.2811	0.3144
Area (sf)	5.1984	5.1984	5,043	5,053	6,063	7,155	8,319	9,114	9,555	10,863	12,243	13,695
Depth (ft)	0.0	1.32	1.33	1.34	2.33	3.33	4.33	4.98	5.33	6.33	7.33	8.33
Elevation (ft)	29.86	66'66	100	100.01	101	102	103	103.65	104	105	106	107

WQ Orifice Sizing:  $D = 24*[(Q/(C[2gH]^{\Lambda}0.5)/3.14]^{\Lambda}0.5$ 

Water Quality Orifice Flow	Constant	Gravitational acceleration	From pond table above	Head
0.15 ft³/s	0.62	32.2 ft/s <sup>2</sup>	4.98 ft	3.32 ft
Ø	U	ρ0	WQ OR depth	I

1.72 in Water Quality Orifice Diameter		
--	--	--

Impervious Area: IA

Proposed Impervious 2.92 ac 127,197 ft²

TOP OF POND = 275---

25-YR WSE

	Water Quality Volume	Water Quality Flow
	12,720 ft³	0.88 ft³/s
SLOPES V Standards	WQV	WQF

Predevelopment Conditions Peak Flowrates (cfs	Peak Flow	rates (cfs)
2	2-year	0.12
1	10-year	0.38
Z	25-year	0.57
•	100,000	0.70

(cfs)	0.11	0.36	0.48	0.62
rates				
Flow		ar.	ar	ar
Proposed Conditions Peak Flowrates (cfs)	2-year	10-year	25-year	100-year
itions		\ .		<u> </u>
Cond				
osed				
Prop				

	WQ Orifice Invert IE		Bottom of Pond					WQV			Max WSE	Top of Pond
Volume (cf)	0	0	0	20	2,358	5,412	9,234	12,842	13,893	19,467	26,025	33,639
Area (ac)	0.0001	0.0001	0.0466	0.0467	0.0617	0.0785	0.0970	0.1127	0.1171	0.1388	0.1623	0.1873
Area (sf)	5.1984	5.1984	2,028	2,034	2,688	3,420	4,224	4,910	5,100	6,048	2,068	8,160
Depth (ft)	0.0	1.32	1.33	1.34	2.33	3.33	4.33	5.12	5.33	6.33	7.33	8.33
Elevation (ft)	29.86	66'66	100	100.01	101	102	103	103.79	104	105	106	107

WQ Orifice Sizing:  $D = 24*[(Q/(C[2gH]^{\Lambda}0.5)/3.14]^{\Lambda}0.5$ 

ŏ	0.07 ft <sup>3</sup> /s	3/s	Water Quality Orifice Flow
O	0.62		Constant
<i>p</i> 00	32.2 ft/s <sup>2</sup>	:/s <sub>2</sub>	Gravitational acceleration
WQ OR depth	5.12 ft		From pond table above
I	3.41 ft		Head

1 24 in Water Origina Dismotor
--------------------------------

Impervious Area:

Proposed Impervious 3.78 ac 164,866 ft²

\_EL = 273.95 TOP OF POND = 275

25-YR WSE

TOP OF WQV

0.4' PERMANENT POOL-

# COB/CWS Standards

Water Quality Volume and Flow: WQV = 0.36 in x IA/12 in/ft WQF = WQV/14400

(4 hours) Water Quality Volume (CWS, 4.05.06) (CWS, 4.05.06)

Water Quality Flow 4,946 ft³ 0.34 ft³/s WQV

Bottom Area Total Depth Top Area Total Volume 38 ft 114 ft 3 :1 Current Pond: Bottom Width Bottom Length Side Slopes

Existing Conditions hear Flowings (Ci.	S LEGIL LION	nares (ci
	2-year	E'0
	10-year	J'T
	25-year	1.4
	100-vear	51

eak Flowrates (cfs)	2-year 0.32	10-year 0.84	:5-year 1.39	100-year 2.16
Proposed Conditions Peak Flowrates (cfs)	2-1	10	25	10

	WQ Orifice Invert IE		Bottom of Pond		WQV			Max WSE	Top of Pond
Volume (cf)	0	0	0	43	5,072	10,596	17,442	25,416	34,590
Area (ac)	0.0001	0.0001	0.0994	0.0997	0.1223	0.1446	0.1697	0.1964	0.2248
Area (sf)	5.1984	5.1984	4,332	4,341	5,329	6,300	7,392	8,556	9,792
Depth (ft)	0.0	1.32	1.33	1.34	2.38	3.33	4.33	5.33	6.33
Elevation (ft)	28.67	66'66	100	100.01	101.05	102	103	104	105

WQ Orifice Sizing:  $D = 24 * [(Q/(C[2gH]^{0.5})/3.14]^{0.5}$ 

Water Quality Orifice Flow	Constant	Gravitational acceleration	From pond table above	Неаф
0.03 ft³/s	0.62	32.2 ft/s <sup>2</sup>	2.38 ft	1.59 ft
			NQ OR depth	

	<u> </u>	
	mete	
	ce Dia	
	Orific	
	ality	
	er Q	
	Wat	
	_	
ĺ	32	
	0.9	

Impervious Area:

Proposed Impervious 5.73 ac 249,814 ft²

EL = 273.95

25-YR WSE

TOP OF WQV

TOP OF POND = 275-

COB/CWS Standards

Water Quality Volume and Flow: WQV = 0.36 in x IA/12 in/ft WQF = WQV/14400

(4 hours) (CWS, 4.05.06) (CWS, 4.05.06)

Water Quality Volume Water Quality Flow 7,494 ft³ 0.52 ft³/s WQV

Current Pond: Bottom Width Bottom Length Side Slopes

Bottom Area Total Depth Top Area Total Volume 49 ft 147 ft 3 :1

Proposed Conditions Peak Flowrates (cfs)

2-year 0.53

10-year	1.46
25-year	2.33
100-year	3.44

	WQ Orifice Invert IE		Bottom of Pond		WQV			Max WSE	Top of Pond
Volume (cf)	0	0	0	72	7,809	16,866	27,243	39,012	52,245
Area (ac)	0.0001	0.0001	0.1654	0.1656	0.1932	0.2227	0.2538	0.2866	0.3210
Area (sf)	5.1984	5.1984	7,203	7,215	8,415	669'6	11,055	12,483	13,983
Depth (ft)	0.0	1.32	1.33	1.34	2.33	3.33	4.33	5.33	6.33
Elevation (ft)	29.86	66'66	100	100.01	101	102	103	104	105

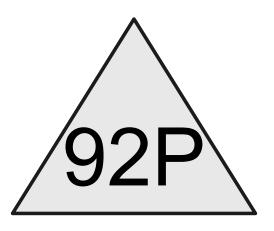
WQ Orifice Sizing:  $D = 24 * [(Q/(C[2gH]^{0.5})/3.14]^{0.5}$ 

Water Quality Orifice Flow	Constant	Gravitational acceleration	From pond table above	Head
0.04 ft³/s	0.62	32.2 ft/s <sup>2</sup>	2.33 ft	1.55 ft
			NQ OR depth	

Water Quality Orifice Diameter	
1.13 in	

Appendix C—HydroCAD Output





## P - M Pond









HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015 Page 2

### **Summary for Pond 92P: P - M Pond**

Inflow Area = 34.280 ac, 49.53% Impervious, Inflow Depth = 1.55" for 2-year Storm event

Inflow = 12.42 cfs @ 7.94 hrs, Volume= 4.420 af

Outflow = 1.44 cfs @ 23.22 hrs, Volume= 4.144 af, Atten= 88%, Lag= 916.4 min

Primary = 1.44 cfs @ 23.22 hrs, Volume= 4.144 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 103.45' @ 23.22 hrs Surf.Area= 0.850 ac Storage= 2.588 af

Plug-Flow detention time= 1,073.2 min calculated for 4.142 af (94% of inflow)

Center-of-Mass det. time= 1,031.5 min (1,756.1 - 724.6)

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	3.981	af 97.00'W x 294.00'L x 5.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
	,		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	2.0" Vert. WQ Orifice/Grate C= 0.600
#3	Device 1	100.80'	5.4" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#4	Device 1	103.50'	6.0' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=1.44 cfs @ 23.22 hrs HW=103.45' (Free Discharge)

**-1=Culvert** (Passes 1.44 cfs of 20.88 cfs potential flow)

2=WQ Orifice/Grate (Orifice Controls 0.20 cfs @ 8.94 fps)

-3=2-yr Orifice/Grate (Orifice Controls 1.25 cfs @ 7.83 fps)

**-4=10/25-yr BCR Weir** (Controls 0.00 cfs)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015 Page 3

## **Summary for Pond 92P: P - M Pond**

Inflow Area = 34.280 ac, 49.53% Impervious, Inflow Depth = 2.41" for 10-year Storm event

Inflow = 19.83 cfs @ 7.93 hrs, Volume= 6.880 af

Outflow = 4.22 cfs @ 11.20 hrs, Volume= 6.597 af, Atten= 79%, Lag= 196.0 min

Primary = 4.22 cfs @ 11.20 hrs, Volume= 6.597 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 103.79' @ 11.20 hrs Surf.Area= 0.871 ac Storage= 2.884 af

Plug-Flow detention time= 782.7 min calculated for 6.594 af (96% of inflow)

Center-of-Mass det. time= 755.3 min (1,470.1 - 714.8)

Volume	Invert	Avail.Stora	ge Storage Description
#1	100.00'	3.981	af 97.00'W x 294.00'L x 5.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
	,		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	2.0" Vert. WQ Orifice/Grate C= 0.600
#3	Device 1	100.80'	5.4" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#4	Device 1	103.50'	6.0' long x 0.5' breadth 10/25-yr BCR Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=4.22 cfs @ 11.20 hrs HW=103.79' (Free Discharge)

**1=Culvert** (Passes 4.22 cfs of 22.30 cfs potential flow)

2=WQ Orifice/Grate (Orifice Controls 0.20 cfs @ 9.37 fps)

-3=2-yr Orifice/Grate (Orifice Controls 1.32 cfs @ 8.33 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 2.69 cfs @ 1.54 fps)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 4

## **Summary for Pond 92P: P - M Pond**

Inflow Area = 34.280 ac, 49.53% Impervious, Inflow Depth = 2.86" for 25-year Storm event

Inflow = 23.71 cfs @ 7.93 hrs, Volume= 8.158 af

Outflow = 6.24 cfs @ 9.66 hrs, Volume= 7.875 af, Atten= 74%, Lag= 103.6 min

Primary = 6.24 cfs @ 9.66 hrs, Volume= 7.875 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 103.91' @ 9.66 hrs Surf.Area= 0.878 ac Storage= 2.992 af

Plug-Flow detention time= 673.5 min calculated for 7.871 af (96% of inflow)

Center-of-Mass det. time= 650.5 min (1,361.2 - 710.7)

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	3.981	af 97.00'W x 294.00'L x 5.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
	•		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	2.0" Vert. WQ Orifice/Grate C= 0.600
#3	Device 1	100.80'	5.4" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#4	Device 1	103.50'	6.0' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

**Primary OutFlow** Max=6.24 cfs @ 9.66 hrs HW=103.91' (Free Discharge)

**—1=Culvert** (Passes 6.24 cfs of 22.78 cfs potential flow)

2=WQ Orifice/Grate (Orifice Controls 0.21 cfs @ 9.53 fps)

-3=2-yr Orifice/Grate (Orifice Controls 1.35 cfs @ 8.50 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 4.69 cfs @ 1.89 fps)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 5

## **Summary for Pond 92P: P - M Pond**

Inflow Area = 34.280 ac, 49.53% Impervious, Inflow Depth = 3.31" for 100-year Storm event

Inflow = 27.67 cfs @ 7.93 hrs, Volume= 9.460 af

Outflow = 9.57 cfs @ 8.94 hrs, Volume= 9.175 af, Atten= 65%, Lag= 60.8 min

Primary = 9.57 cfs @ 8.94 hrs, Volume= 9.175 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 104.07' @ 8.94 hrs Surf.Area= 0.888 ac Storage= 3.132 af

Plug-Flow detention time= 590.5 min calculated for 9.171 af (97% of inflow)

Center-of-Mass det. time= 570.8 min (1,277.7 - 707.0)

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	3.981	af 97.00'W x 294.00'L x 5.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
	•		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	2.0" Vert. WQ Orifice/Grate C= 0.600
#3	Device 1	100.80'	5.4" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#4	Device 1	103.50'	6.0' long x 0.5' breadth 10/25-yr BCR Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

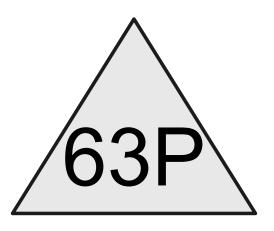
Primary OutFlow Max=9.57 cfs @ 8.94 hrs HW=104.07' (Free Discharge)

**1=Culvert** (Passes 9.57 cfs of 23.40 cfs potential flow)

2=WQ Orifice/Grate (Orifice Controls 0.21 cfs @ 9.72 fps)

-3=2-yr Orifice/Grate (Orifice Controls 1.39 cfs @ 8.71 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 7.97 cfs @ 2.32 fps)



## P - N Pond









HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015

Page 2

### **Summary for Pond 63P: P - N Pond**

Inflow Area = 2.740 ac, 56.93% Impervious, Inflow Depth = 1.65" for 2-year Storm event

Inflow = 1.08 cfs @ 7.93 hrs, Volume= 0.378 af

Outflow = 0.10 cfs @ 24.03 hrs, Volume= 0.346 af, Atten= 91%, Lag= 965.7 min

Primary = 0.10 cfs @ 24.03 hrs, Volume= 0.346 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 103.28' @ 24.03 hrs Surf.Area= 0.108 ac Storage= 0.255 af

Plug-Flow detention time= 1,371.3 min calculated for 0.346 af (92% of inflow)

Center-of-Mass det. time= 1,315.7 min ( 2,030.1 - 714.4 )

Volume	Invert	Avail.Stora	ge Storage Description
#1	100.00'	0.471	af 27.00'W x 81.00'L x 5.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
			L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	0.6" Horiz. WQ Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Device 1	100.90'	1.4" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#4	Device 1	103.50'	5.0' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.10 cfs @ 24.03 hrs HW=103.28' (Free Discharge)

**-1=Culvert** (Passes 0.10 cfs of 20.17 cfs potential flow)

**-2=WQ Orifice/Grate** (Orifice Controls 0.02 cfs @ 8.73 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.08 cfs @ 7.43 fps)

**4=10/25-yr BCR Weir** (Controls 0.00 cfs)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015 Page 3

### **Summary for Pond 63P: P - N Pond**

Inflow Area = 2.740 ac, 56.93% Impervious, Inflow Depth = 2.53" for 10-year Storm event

Inflow = 1.68 cfs @ 7.93 hrs, Volume= 0.579 af

Outflow = 0.31 cfs @ 12.58 hrs, Volume= 0.546 af, Atten= 82%, Lag= 279.0 min

Primary = 0.31 cfs @ 12.58 hrs, Volume= 0.546 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 103.56' @ 12.58 hrs Surf.Area= 0.114 ac Storage= 0.285 af

Plug-Flow detention time= 1,065.9 min calculated for 0.546 af (94% of inflow)

Center-of-Mass det. time= 1,025.3 min ( 1,730.5 - 705.2 )

Volume	Invert	Avail.Stora	ige Storage Description
#1	100.00'	0.471	af 27.00'W x 81.00'L x 5.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
	•		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	0.6" Horiz. WQ Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Device 1	100.90'	1.4" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#4	Device 1	103.50'	5.0' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

**Primary OutFlow** Max=0.31 cfs @ 12.58 hrs HW=103.56' (Free Discharge)

**-1=Culvert** (Passes 0.31 cfs of 21.36 cfs potential flow)

2=WQ Orifice/Grate (Orifice Controls 0.02 cfs @ 9.09 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.08 cfs @ 7.85 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 0.21 cfs @ 0.69 fps)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 4

## Summary for Pond 63P: P - N Pond

Inflow Area = 2.740 ac, 56.93% Impervious, Inflow Depth = 2.99" for 25-year Storm event

Inflow = 1.99 cfs @ 7.92 hrs, Volume= 0.683 af

Outflow = 0.48 cfs @ 10.02 hrs, Volume= 0.649 af, Atten= 76%, Lag= 125.6 min

Primary = 0.48 cfs @ 10.02 hrs, Volume= 0.649 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 103.59' @ 10.02 hrs Surf.Area= 0.114 ac Storage= 0.289 af

Plug-Flow detention time= 912.0 min calculated for 0.649 af (95% of inflow)

Center-of-Mass det. time= 878.9 min (1,580.4 - 701.5)

Volume	Invert	Avail.Stora	ige Storage Description
#1	100.00'	0.471	af 27.00'W x 81.00'L x 5.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
	•		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	0.6" Horiz. WQ Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Device 1	100.90'	1.4" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#4	Device 1	103.50'	5.0' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.48 cfs @ 10.02 hrs HW=103.59' (Free Discharge)

**-1=Culvert** (Passes 0.48 cfs of 21.48 cfs potential flow)

**2=WQ Orifice/Grate** (Orifice Controls 0.02 cfs @ 9.12 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.08 cfs @ 7.90 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 0.38 cfs @ 0.84 fps)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 5

## Summary for Pond 63P: P - N Pond

Inflow Area = 2.740 ac, 56.93% Impervious, Inflow Depth = 3.45" for 100-year Storm event

Inflow = 2.31 cfs @ 7.92 hrs, Volume= 0.788 af

Outflow = 0.77 cfs @ 8.98 hrs, Volume= 0.755 af, Atten= 67%, Lag= 63.3 min

Primary = 0.77 cfs @ 8.98 hrs, Volume= 0.755 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 103.63' @ 8.98 hrs Surf.Area= 0.115 ac Storage= 0.294 af

Plug-Flow detention time= 795.3 min calculated for 0.755 af (96% of inflow)

Center-of-Mass det. time= 766.7 min (1,464.8 - 698.1)

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	0.471	af 27.00'W x 81.00'L x 5.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	<b>24.0" Round Culvert</b> L= 100.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	<b>0.6" Horiz. WQ Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#3	Device 1	100.90'	<b>1.4" Horiz. 2-yr Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#4	Device 1	103.50'	5.0' long x 0.5' breadth 10/25-yr BCR Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

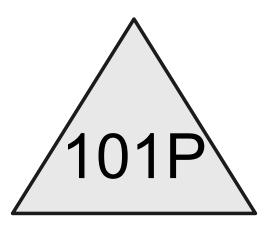
**Primary OutFlow** Max=0.77 cfs @ 8.98 hrs HW=103.63' (Free Discharge)

1=Culvert (Passes 0.77 cfs of 21.65 cfs potential flow)

-2=WQ Orifice/Grate (Orifice Controls 0.02 cfs @ 9.18 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.09 cfs @ 7.96 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 0.67 cfs @ 1.02 fps)



## P - O Pond









HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015

Page 2

## **Summary for Pond 101P: P - O Pond**

Inflow Area = 5.520 ac, 59.24% Impervious, Inflow Depth = 1.69" for 2-year Storm event

Inflow = 2.23 cfs @ 7.93 hrs, Volume= 0.776 af

Outflow = 0.21 cfs @ 24.01 hrs, Volume= 0.724 af, Atten= 91%, Lag= 964.6 min

Primary = 0.21 cfs @ 24.01 hrs, Volume= 0.724 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 103.53' @ 24.01 hrs Surf.Area= 0.188 ac Storage= 0.506 af

Plug-Flow detention time= 1,308.1 min calculated for 0.724 af (93% of inflow)

Center-of-Mass det. time= 1,260.8 min ( 1,972.3 - 711.5 )

Volume	Invert	Avail.Stora	ige Storage Description		
#1	100.00'	0.812	2 af 38.00'W x 117.00'L x 5.00'H Prismatoid Z=3.0		
Device	Routing	Invert	Outlet Devices		
#1	Primary	100.00'	24.0" Round Culvert		
	•		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700		
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900		
			n= 0.013, Flow Area= 3.14 sf		
#2	Device 1	98.67'	0.9" Horiz. WQ Orifice/Grate C= 0.600		
			Limited to weir flow at low heads		
#3	Device 1	100.90'	2.0" Horiz. 2-yr Orifice/Grate C= 0.600		
			Limited to weir flow at low heads		
#4	Device 1	103.60'	3.0' long x 0.5' breadth 10/25-yr BCR Weir		
			Head (feet) 0.20 0.40 0.60 0.80 1.00		
			Coef. (English) 2.80 2.92 3.08 3.30 3.32		

Primary OutFlow Max=0.21 cfs @ 24.01 hrs HW=103.53' (Free Discharge)

**-1=Culvert** (Passes 0.21 cfs of 21.24 cfs potential flow)

-2=WQ Orifice/Grate (Orifice Controls 0.04 cfs @ 9.05 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.17 cfs @ 7.81 fps)

**4=10/25-yr BCR Weir** ( Controls 0.00 cfs)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015 Page 3

## **Summary for Pond 101P: P - O Pond**

Inflow Area = 5.520 ac, 59.24% Impervious, Inflow Depth = 2.57" for 10-year Storm event

Inflow = 3.45 cfs @ 7.93 hrs, Volume= 1.184 af

Outflow = 0.69 cfs @ 11.38 hrs, Volume= 1.130 af, Atten= 80%, Lag= 207.4 min

Primary = 0.69 cfs @ 11.38 hrs, Volume= 1.130 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 103.75' @ 11.38 hrs Surf.Area= 0.194 ac Storage= 0.547 af

Plug-Flow detention time= 961.3 min calculated for 1.129 af (95% of inflow)

Center-of-Mass det. time= 930.4 min (1,632.8 - 702.4)

Volume	Invert	Avail.Stora	nge Storage Description		
#1	100.00'	0.812	2 af 38.00'W x 117.00'L x 5.00'H Prismatoid Z=3.0		
Device	Routing	Invert	Outlet Devices		
#1	Primary	100.00'	24.0" Round Culvert		
	•		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700		
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900		
			n= 0.013, Flow Area= 3.14 sf		
#2	Device 1	98.67'	0.9" Horiz. WQ Orifice/Grate C= 0.600		
			Limited to weir flow at low heads		
#3	Device 1	100.90'	2.0" Horiz. 2-yr Orifice/Grate C= 0.600		
			Limited to weir flow at low heads		
#4	Device 1	103.60'	3.0' long x 0.5' breadth 10/25-yr BCR Weir		
			Head (feet) 0.20 0.40 0.60 0.80 1.00		
			Coef. (English) 2.80 2.92 3.08 3.30 3.32		

Primary OutFlow Max=0.69 cfs @ 11.38 hrs HW=103.75' (Free Discharge)

**-1=Culvert** (Passes 0.69 cfs of 22.12 cfs potential flow)

-2=WQ Orifice/Grate (Orifice Controls 0.04 cfs @ 9.32 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.18 cfs @ 8.12 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 0.47 cfs @ 1.07 fps)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 4

## **Summary for Pond 101P: P - O Pond**

Inflow Area = 5.520 ac, 59.24% Impervious, Inflow Depth = 3.03" for 25-year Storm event

Inflow = 4.08 cfs @ 7.92 hrs, Volume= 1.394 af

Outflow = 1.02 cfs @ 9.83 hrs, Volume= 1.340 af, Atten= 75%, Lag= 114.6 min

Primary = 1.02 cfs @ 9.83 hrs, Volume= 1.340 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 103.81' @ 9.83 hrs Surf.Area= 0.195 ac Storage= 0.559 af

Plug-Flow detention time= 827.6 min calculated for 1.340 af (96% of inflow)

Center-of-Mass det. time= 801.4 min (1,500.1 - 698.8)

Volume	Invert	Avail.Stora	ige Storage Description		
#1	100.00'	0.812	2 af 38.00'W x 117.00'L x 5.00'H Prismatoid Z=3.0		
Device	Routing	Invert	Outlet Devices		
#1	Primary	100.00'	24.0" Round Culvert		
	•		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700		
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900		
			n= 0.013, Flow Area= 3.14 sf		
#2	Device 1	98.67'	0.9" Horiz. WQ Orifice/Grate C= 0.600		
			Limited to weir flow at low heads		
#3	Device 1	100.90'	2.0" Horiz. 2-yr Orifice/Grate C= 0.600		
			Limited to weir flow at low heads		
#4	Device 1	103.60'	3.0' long x 0.5' breadth 10/25-yr BCR Weir		
			Head (feet) 0.20 0.40 0.60 0.80 1.00		
			Coef. (English) 2.80 2.92 3.08 3.30 3.32		

Primary OutFlow Max=1.02 cfs @ 9.83 hrs HW=103.81' (Free Discharge)

**-1=Culvert** (Passes 1.02 cfs of 22.37 cfs potential flow)

-2=WQ Orifice/Grate (Orifice Controls 0.04 cfs @ 9.40 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.18 cfs @ 8.21 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 0.80 cfs @ 1.28 fps)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 5

## **Summary for Pond 101P: P - O Pond**

Inflow Area = 5.520 ac, 59.24% Impervious, Inflow Depth = 3.49" for 100-year Storm event

Inflow = 4.72 cfs @ 7.92 hrs, Volume= 1.608 af

Outflow = 1.60 cfs @ 8.95 hrs, Volume= 1.554 af, Atten= 66%, Lag= 61.5 min

Primary = 1.60 cfs @ 8.95 hrs, Volume= 1.554 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 103.90' @ 8.95 hrs Surf.Area= 0.198 ac Storage= 0.576 af

Plug-Flow detention time= 727.2 min calculated for 1.554 af (97% of inflow)

Center-of-Mass det. time= 702.6 min (1,398.1 - 695.5)

Volume	Invert	Avail.Stora	ige Storage Description		
#1	100.00'	0.812	2 af 38.00'W x 117.00'L x 5.00'H Prismatoid Z=3.0		
Device	Routing	Invert	Outlet Devices		
#1	Primary	100.00'	24.0" Round Culvert		
	•		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700		
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900		
			n= 0.013, Flow Area= 3.14 sf		
#2	Device 1	98.67'	0.9" Horiz. WQ Orifice/Grate C= 0.600		
			Limited to weir flow at low heads		
#3	Device 1	100.90'	2.0" Horiz. 2-yr Orifice/Grate C= 0.600		
			Limited to weir flow at low heads		
#4	Device 1	103.60'	3.0' long x 0.5' breadth 10/25-yr BCR Weir		
			Head (feet) 0.20 0.40 0.60 0.80 1.00		
			Coef. (English) 2.80 2.92 3.08 3.30 3.32		

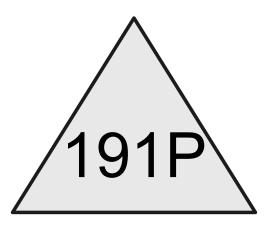
Primary OutFlow Max=1.60 cfs @ 8.95 hrs HW=103.90' (Free Discharge)

**-1=Culvert** (Passes 1.60 cfs of 22.71 cfs potential flow)

-2=WQ Orifice/Grate (Orifice Controls 0.04 cfs @ 9.50 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.18 cfs @ 8.33 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 1.38 cfs @ 1.55 fps)



## P - P1 Pond









HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015 Page 2

## **Summary for Pond 191P: P - P1 Pond**

Inflow Area = 5.820 ac, 58.25% Impervious, Inflow Depth = 1.67" for 2-year Storm event

Inflow = 2.32 cfs @ 7.93 hrs, Volume= 0.811 af

Outflow = 0.17 cfs @ 24.06 hrs, Volume= 0.733 af, Atten= 93%, Lag= 967.4 min

Primary = 0.17 cfs @ 24.06 hrs, Volume= 0.733 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 105.24' @ 24.06 hrs Surf.Area= 0.174 ac Storage= 0.604 af

Plug-Flow detention time= 1,871.2 min calculated for 0.733 af (90% of inflow)

Center-of-Mass det. time= 1,806.1 min (2,518.8 - 712.7)

Volume	Invert	Avail.Stora	Storage Description	
#1	100.00'	0.951	31.00'W x 90.00'L x 7.00'H Pri	smatoid Z=3.0
Device	Routing	Invert	et Devices	
#1	Primary	100.00'	" Round Culvert 00.0' RCP, mitered to conform / Outlet Invert= 100.00' / 99.00' 0.013, Flow Area= 3.14 sf	
#2	Device 1	98.67'	Horiz. WQ Orifice/Grate C= (	0.600
#3	Device 1	103.55'	Horiz. 2-yr Orifice/Grate C= ted to weir flow at low heads	0.600
#4	Device 1	105.55'	long x 0.5' breadth 10-yr BCF d (feet) 0.20 0.40 0.60 0.80 f. (English) 2.80 2.92 3.08 3.3	1.00
#5	Device 1	105.95'	long x 0.5' breadth 25-yr BCF d (feet) 0.20 0.40 0.60 0.80 f. (English) 2.80 2.92 3.08 3.3	R Weir 1.00

Primary OutFlow Max=0.17 cfs @ 24.06 hrs HW=105.24' (Free Discharge)

**-1=Culvert** (Passes 0.17 cfs of 27.49 cfs potential flow)

2=WQ Orifice/Grate (Orifice Controls 0.10 cfs @ 11.02 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.07 cfs @ 6.26 fps)

-4=10-yr BCR Weir (Controls 0.00 cfs)

5=25-yr BCR Weir (Controls 0.00 cfs)

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015 Page 3

## **Summary for Pond 191P: P - P1 Pond**

Inflow Area = 5.820 ac, 58.25% Impervious, Inflow Depth = 2.56" for 10-year Storm event

Inflow = 3.61 cfs @ 7.93 hrs, Volume= 1.240 af

Outflow = 0.54 cfs @ 16.99 hrs, Volume= 1.136 af, Atten= 85%, Lag= 544.0 min

Primary = 0.54 cfs @ 16.99 hrs, Volume= 1.136 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 105.94' @ 16.99 hrs Surf.Area= 0.192 ac Storage= 0.731 af

Plug-Flow detention time= 1,471.1 min calculated for 1.136 af (92% of inflow)

Center-of-Mass det. time= 1,414.0 min (2,117.6 - 703.6)

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	0.951	af 31.00'W x 90.00'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	<b>24.0" Round Culvert</b> L= 100.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	<b>1.3" Horiz. WQ Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#3	Device 1	103.55'	1.4" Horiz. 2-yr Orifice/Grate C= 0.600 Limited to weir flow at low heads
#4	Device 1	105.55'	<b>0.5' long x 0.5' breadth 10-yr BCR Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#5	Device 1	105.95'	6.0' long x 0.5' breadth 25-yr BCR Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.54 cfs @ 16.99 hrs HW=105.94' (Free Discharge)

**\_1=Culvert** (Passes 0.54 cfs of 29.65 cfs potential flow)

**2=WQ Orifice/Grate** (Orifice Controls 0.11 cfs @ 11.73 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.08 cfs @ 7.44 fps)

**-4=10-yr BCR Weir** (Weir Controls 0.35 cfs @ 1.81 fps)

-5=25-yr BCR Weir (Controls 0.00 cfs)

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 4

## **Summary for Pond 191P: P - P1 Pond**

Inflow Area = 5.820 ac, 58.25% Impervious, Inflow Depth = 3.01" for 25-year Storm event

Inflow = 4.27 cfs @ 7.92 hrs, Volume= 1.461 af

Outflow = 0.76 cfs @ 12.62 hrs, Volume= 1.357 af, Atten= 82%, Lag= 282.0 min

Primary = 0.76 cfs @ 12.62 hrs, Volume= 1.357 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 105.99' @ 12.62 hrs Surf.Area= 0.194 ac Storage= 0.742 af

Plug-Flow detention time= 1,269.1 min calculated for 1.356 af (93% of inflow)

Center-of-Mass det. time= 1,219.9 min (1,919.8 - 699.9)

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	0.951	af 31.00'W x 90.00'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	<b>24.0" Round Culvert</b> L= 100.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	<b>1.3" Horiz. WQ Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#3	Device 1	103.55'	1.4" Horiz. 2-yr Orifice/Grate C= 0.600 Limited to weir flow at low heads
#4	Device 1	105.55'	<b>0.5' long x 0.5' breadth 10-yr BCR Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#5	Device 1	105.95'	6.0' long x 0.5' breadth 25-yr BCR Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.76 cfs @ 12.62 hrs HW=105.99' (Free Discharge)

**1=Culvert** (Passes 0.76 cfs of 29.82 cfs potential flow)

**2=WQ Orifice/Grate** (Orifice Controls 0.11 cfs @ 11.79 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.08 cfs @ 7.52 fps)

**-4=10-yr BCR Weir** (Weir Controls 0.43 cfs @ 1.96 fps)

**—5=25-yr BCR Weir** (Weir Controls 0.14 cfs @ 0.57 fps)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 5

## **Summary for Pond 191P: P - P1 Pond**

Inflow Area = 5.820 ac, 58.25% Impervious, Inflow Depth = 3.48" for 100-year Storm event

Inflow = 4.95 cfs @ 7.92 hrs, Volume= 1.686 af

Outflow = 1.10 cfs @ 10.35 hrs, Volume= 1.580 af, Atten= 78%, Lag= 145.9 min

Primary = 1.10 cfs @ 10.35 hrs, Volume= 1.580 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 106.03' @ 10.35 hrs Surf.Area= 0.195 ac Storage= 0.750 af

Plug-Flow detention time= 1,109.1 min calculated for 1.579 af (94% of inflow)

Center-of-Mass det. time= 1,066.0 min ( 1,762.6 - 696.6 )

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	0.951	af 31.00'W x 90.00'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	<b>24.0" Round Culvert</b> L= 100.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	<b>1.3" Horiz. WQ Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#3	Device 1	103.55'	
#4	Device 1	105.55'	<b>0.5' long x 0.5' breadth 10-yr BCR Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#5	Device 1	105.95'	6.0' long x 0.5' breadth 25-yr BCR Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=1.10 cfs @ 10.35 hrs HW=106.03' (Free Discharge)

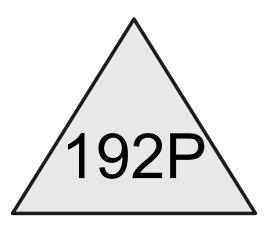
**\_1=Culvert** (Passes 1.10 cfs of 29.95 cfs potential flow)

**2=WQ Orifice/Grate** (Orifice Controls 0.11 cfs @ 11.83 fps)

**−3=2-yr Orifice/Grate** (Orifice Controls 0.08 cfs @ 7.59 fps)

**4=10-yr BCR Weir** (Weir Controls 0.50 cfs @ 2.08 fps)

**-5=25-yr BCR Weir** (Weir Controls 0.41 cfs @ 0.81 fps)



## P-P2 Pond









HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015 Page 2

## Summary for Pond 192P: P - P2 Pond

Inflow Area = 0.930 ac, 54.84% Impervious, Inflow Depth = 1.62" for 2-year Storm event

Inflow = 0.36 cfs @ 7.94 hrs, Volume= 0.126 af

Outflow = 0.02 cfs @ 24.08 hrs, Volume= 0.112 af, Atten= 94%, Lag= 968.4 min

Primary = 0.02 cfs @ 24.08 hrs, Volume= 0.112 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 105.13' @ 24.08 hrs Surf.Area= 0.042 ac Storage= 0.097 af

Plug-Flow detention time= 2,034.8 min calculated for 0.112 af (89% of inflow)

Center-of-Mass det. time= 1,961.8 min (2,678.9 - 717.2)

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	0.199	af 6.50'W x 18.75'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert L= 100.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	·
#3	Device 1	103.99'	<b>0.5" Horiz. 2-yr Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#4	Device 1	105.50'	<b>0.5' long x 0.5' breadth 10/25-yr BCR Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.02 cfs @ 24.08 hrs HW=105.13' (Free Discharge)

**-1=Culvert** (Passes 0.02 cfs of 27.12 cfs potential flow)

**-2=WQ Orifice/Grate** (Orifice Controls 0.01 cfs @ 10.90 fps)

**-3=2-yr Orifice/Grate** (Orifice Controls 0.01 cfs @ 5.14 fps)

**-4=10/25-yr BCR Weir** ( Controls 0.00 cfs)

Printed 11/30/2015

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 3

## **Summary for Pond 192P: P - P2 Pond**

Inflow Area = 0.930 ac, 54.84% Impervious, Inflow Depth = 2.50" for 10-year Storm event

Inflow = 0.56 cfs @ 7.93 hrs, Volume= 0.194 af

Outflow = 0.09 cfs @ 16.79 hrs, Volume= 0.172 af, Atten= 85%, Lag= 531.4 min

Primary = 0.09 cfs @ 16.79 hrs, Volume= 0.172 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 105.62' @ 16.79 hrs Surf.Area= 0.049 ac Storage= 0.120 af

Plug-Flow detention time= 1,632.8 min calculated for 0.172 af (89% of inflow)

Center-of-Mass det. time= 1,556.5 min (2,264.4 - 707.9)

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	0.199	af 6.50'W x 18.75'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert L= 100.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	·
#3	Device 1	103.99'	<b>0.5" Horiz. 2-yr Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#4	Device 1	105.50'	<b>0.5' long x 0.5' breadth 10/25-yr BCR Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

**Primary OutFlow** Max=0.09 cfs @ 16.79 hrs HW=105.62' (Free Discharge)

**-1=Culvert** (Passes 0.09 cfs of 28.70 cfs potential flow)

**-2=WQ Orifice/Grate** (Orifice Controls 0.02 cfs @ 11.42 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.01 cfs @ 6.16 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 0.06 cfs @ 0.99 fps)

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 4

## Summary for Pond 192P: P - P2 Pond

Inflow Area = 0.930 ac, 54.84% Impervious, Inflow Depth = 2.95" for 25-year Storm event

Inflow = 0.67 cfs @ 7.93 hrs, Volume= 0.229 af

Outflow = 0.11 cfs @ 13.51 hrs, Volume= 0.207 af, Atten= 83%, Lag= 335.2 min

Primary = 0.11 cfs @ 13.51 hrs, Volume= 0.207 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 105.66' @ 13.51 hrs Surf.Area= 0.049 ac Storage= 0.122 af

Plug-Flow detention time= 1,396.1 min calculated for 0.207 af (90% of inflow)

Center-of-Mass det. time= 1,330.6 min ( 2,034.6 - 704.0 )

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	0.199	af 6.50'W x 18.75'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert L= 100.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	·
#3	Device 1	103.99'	<b>0.5" Horiz. 2-yr Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#4	Device 1	105.50'	<b>0.5' long x 0.5' breadth 10/25-yr BCR Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.11 cfs @ 13.51 hrs HW=105.66' (Free Discharge)

-1=Culvert (Passes 0.11 cfs of 28.82 cfs potential flow)

-2=WQ Orifice/Grate (Orifice Controls 0.02 cfs @ 11.46 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.01 cfs @ 6.22 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 0.09 cfs @ 1.12 fps)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 5

## **Summary for Pond 192P: P - P2 Pond**

Inflow Area = 0.930 ac, 54.84% Impervious, Inflow Depth = 3.41" for 100-year Storm event

Inflow = 0.78 cfs @ 7.92 hrs, Volume= 0.264 af

Outflow = 0.16 cfs @ 11.31 hrs, Volume= 0.242 af, Atten= 80%, Lag= 202.9 min

Primary = 0.16 cfs @ 11.31 hrs, Volume= 0.242 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 105.71' @ 11.31 hrs Surf.Area= 0.050 ac Storage= 0.124 af

Plug-Flow detention time= 1,215.7 min calculated for 0.242 af (92% of inflow)

Center-of-Mass det. time= 1,156.8 min (1,857.3 - 700.6)

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	0.199	af 6.50'W x 18.75'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
			L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	<b>0.5" Horiz. WQ Orifice/Grate</b> C= 0.600
			Limited to weir flow at low heads
#3	Device 1	103.99'	<b>0.5" Horiz. 2-yr Orifice/Grate</b> C= 0.600
			Limited to weir flow at low heads
#4	Device 1	105.50'	0.5' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

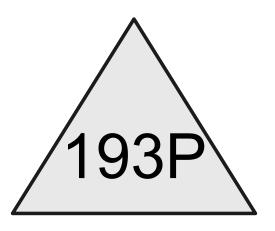
**Primary OutFlow** Max=0.16 cfs @ 11.31 hrs HW=105.71' (Free Discharge)

**-1=Culvert** (Passes 0.16 cfs of 28.95 cfs potential flow)

**—2=WQ Orifice/Grate** (Orifice Controls 0.02 cfs @ 11.50 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.01 cfs @ 6.31 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 0.13 cfs @ 1.27 fps)



# P-P3 Pond









Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015

Page 2

## Summary for Pond 193P: P - P3 Pond

Inflow Area = 8.630 ac, 67.67% Impervious, Inflow Depth = 1.81" for 2-year Storm event

Inflow = 3.79 cfs @ 7.92 hrs, Volume= 1.300 af

Outflow = 0.25 cfs @ 24.06 hrs, Volume= 1.171 af, Atten= 93%, Lag= 968.1 min

Primary = 0.25 cfs @ 24.06 hrs, Volume= 1.171 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 105.34' @ 24.06 hrs Surf.Area= 0.260 ac Storage= 0.982 af

Plug-Flow detention time= 1,943.7 min calculated for 1.171 af (90% of inflow)

Center-of-Mass det. time= 1,874.8 min ( 2,576.5 - 701.7 )

Volume	Invert	Avail.Stora	ge Storage Description
#1	100.00'	1.458	af 41.00'W x 123.00'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
	•		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	1.7" Horiz. WQ Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Device 1	103.65'	1.5" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#4	Device 1	105.50'	1.0' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.25 cfs @ 24.06 hrs HW=105.34' (Free Discharge)

**-1=Culvert** (Passes 0.25 cfs of 27.80 cfs potential flow)

**-2=WQ Orifice/Grate** (Orifice Controls 0.18 cfs @ 11.13 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.08 cfs @ 6.26 fps)

**-4=10/25-yr BCR Weir** (Controls 0.00 cfs)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015 Page 3

## Summary for Pond 193P: P - P3 Pond

Inflow Area = 8.630 ac, 67.67% Impervious, Inflow Depth = 2.72" for 10-year Storm event

Inflow = 5.73 cfs @ 7.92 hrs, Volume= 1.954 af

Outflow = 0.87 cfs @ 15.60 hrs, Volume= 1.799 af, Atten= 85%, Lag= 460.8 min

Primary = 0.87 cfs @ 15.60 hrs, Volume= 1.799 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 105.85' @ 15.60 hrs Surf.Area= 0.276 ac Storage= 1.119 af

Plug-Flow detention time= 1,473.4 min calculated for 1.798 af (92% of inflow)

Center-of-Mass det. time= 1,418.4 min (2,111.3 - 692.9)

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	1.458	3 af 41.00'W x 123.00'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
-			
#1	Primary	100.00	24.0" Round Culvert
			L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	1.7" Horiz. WQ Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Device 1	103.65'	1.5" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#4	Device 1	105.50'	1.0' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32
			333. (E.I.g.i.) 1.33 1.31 3.33 3.32

**Primary OutFlow** Max=0.87 cfs @ 15.60 hrs HW=105.85' (Free Discharge)

**—1=Culvert** (Passes 0.87 cfs of 29.39 cfs potential flow)

**2=WQ Orifice/Grate** (Orifice Controls 0.18 cfs @ 11.65 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.09 cfs @ 7.14 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 0.60 cfs @ 1.71 fps)

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 4

## **Summary for Pond 193P: P - P3 Pond**

Inflow Area = 8.630 ac, 67.67% Impervious, Inflow Depth = 3.18" for 25-year Storm event

Inflow = 6.73 cfs @ 7.92 hrs, Volume= 2.289 af

Outflow = 1.16 cfs @ 12.63 hrs, Volume= 2.132 af, Atten= 83%, Lag= 283.1 min

Primary = 1.16 cfs @ 12.63 hrs, Volume= 2.132 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 105.95' @ 12.63 hrs Surf.Area= 0.279 ac Storage= 1.146 af

Plug-Flow detention time= 1,275.6 min calculated for 2.131 af (93% of inflow)

Center-of-Mass det. time= 1,228.0 min (1,917.5 - 689.5)

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	1.458	3 af 41.00'W x 123.00'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
-			
#1	Primary	100.00	24.0" Round Culvert
			L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	1.7" Horiz. WQ Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Device 1	103.65'	1.5" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#4	Device 1	105.50'	1.0' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32
			333. (E.I.g.i.) 1.33 1.31 3.33 3.32

**Primary OutFlow** Max=1.16 cfs @ 12.63 hrs HW=105.95' (Free Discharge)

**-1=Culvert** (Passes 1.16 cfs of 29.69 cfs potential flow)

**2=WQ Orifice/Grate** (Orifice Controls 0.19 cfs @ 11.74 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.09 cfs @ 7.30 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 0.89 cfs @ 1.98 fps)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 5

## Summary for Pond 193P: P - P3 Pond

Inflow Area = 8.630 ac, 67.67% Impervious, Inflow Depth = 3.65" for 100-year Storm event

Inflow = 7.75 cfs @ 7.91 hrs, Volume= 2.628 af

Outflow = 1.60 cfs @ 10.93 hrs, Volume= 2.470 af, Atten= 79%, Lag= 181.0 min

Primary = 1.60 cfs @ 10.93 hrs, Volume= 2.470 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 106.07' @ 10.93 hrs Surf.Area= 0.283 ac Storage= 1.181 af

Plug-Flow detention time= 1,122.2 min calculated for 2.469 af (94% of inflow)

Center-of-Mass det. time= 1,080.4 min ( 1,766.8 - 686.5 )

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	1.458	3 af 41.00'W x 123.00'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
-			
#1	Primary	100.00	24.0" Round Culvert
			L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	1.7" Horiz. WQ Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Device 1	103.65'	1.5" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#4	Device 1	105.50'	1.0' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32
			333. (E.I.g.i.) 1.33 1.31 3.33 3.32

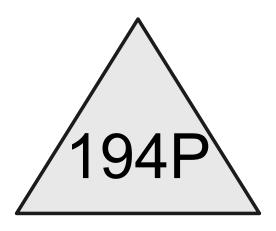
**Primary OutFlow** Max=1.60 cfs @ 10.93 hrs HW=106.07' (Free Discharge)

**-1=Culvert** (Passes 1.60 cfs of 30.06 cfs potential flow)

**2=WQ Orifice/Grate** (Orifice Controls 0.19 cfs @ 11.87 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.09 cfs @ 7.49 fps)

**—4=10/25-yr BCR Weir** (Weir Controls 1.32 cfs @ 2.31 fps)



# P - P4 Pond









Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015

Page 2

## **Summary for Pond 194P: P - P4 Pond**

Inflow Area = 4.070 ac, 64.86% Impervious, Inflow Depth = 1.77" for 2-year Storm event

Inflow = 1.74 cfs @ 7.93 hrs, Volume= 0.599 af

Outflow = 0.11 cfs @ 24.06 hrs, Volume= 0.551 af, Atten= 93%, Lag= 968.2 min

Primary = 0.11 cfs @ 24.06 hrs, Volume= 0.551 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 105.05' @ 24.06 hrs Surf.Area= 0.140 ac Storage= 0.453 af

Plug-Flow detention time= 1,969.5 min calculated for 0.551 af (92% of inflow)

Center-of-Mass det. time= 1,912.6 min ( 2,617.4 - 704.8 )

Volume	Invert	Avail.Stora	ge Storage Description
#1	100.00'	0.771	af 26.00'W x 78.00'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
			L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	1.2" Horiz. WQ Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Device 1	103.79'	1.0" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#4	Device 1	105.60'	0.5' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.11 cfs @ 24.06 hrs HW=105.05' (Free Discharge)

-1=Culvert (Passes 0.11 cfs of 26.86 cfs potential flow)

**-2=WQ Orifice/Grate** (Orifice Controls 0.08 cfs @ 10.82 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.03 cfs @ 5.41 fps)

**-4=10/25-yr BCR Weir** ( Controls 0.00 cfs)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015 Page 3

## **Summary for Pond 194P: P - P4 Pond**

Inflow Area = 4.070 ac, 64.86% Impervious, Inflow Depth = 2.67" for 10-year Storm event

Inflow = 2.65 cfs @ 7.92 hrs, Volume= 0.905 af

Outflow = 0.36 cfs @ 18.35 hrs, Volume= 0.821 af, Atten= 86%, Lag= 626.0 min

Primary = 0.36 cfs @ 18.35 hrs, Volume= 0.821 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 105.89' @ 18.35 hrs Surf.Area= 0.160 ac Storage= 0.580 af

Plug-Flow detention time= 1,668.6 min calculated for 0.821 af (91% of inflow)

Center-of-Mass det. time= 1,604.8 min ( 2,300.7 - 696.0 )

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	0.771	1 af 26.00'W x 78.00'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	<b>24.0" Round Culvert</b> L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	· · · · · · · · · · · · · · · · · · ·
#3	Device 1	103.79'	<b>1.0" Horiz. 2-yr Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#4	Device 1	105.60'	<b>0.5' long x 0.5' breadth 10/25-yr BCR Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.36 cfs @ 18.35 hrs HW=105.89' (Free Discharge)

**—1=Culvert** (Passes 0.36 cfs of 29.53 cfs potential flow)

**—2=WQ Orifice/Grate** (Orifice Controls 0.09 cfs @ 11.69 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.04 cfs @ 6.98 fps)

**—4=10/25-yr BCR Weir** (Weir Controls 0.23 cfs @ 1.55 fps)

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 4

## **Summary for Pond 194P: P - P4 Pond**

Inflow Area = 4.070 ac, 64.86% Impervious, Inflow Depth = 3.13" for 25-year Storm event

Inflow = 3.12 cfs @ 7.92 hrs, Volume= 1.062 af

Outflow = 0.48 cfs @ 15.25 hrs, Volume= 0.977 af, Atten= 85%, Lag= 440.0 min

Primary = 0.48 cfs @ 15.25 hrs, Volume= 0.977 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 105.99' @ 15.25 hrs Surf.Area= 0.162 ac Storage= 0.594 af

Plug-Flow detention time= 1,449.1 min calculated for 0.977 af (92% of inflow)

Center-of-Mass det. time= 1,393.7 min ( 2,086.2 - 692.5 )

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	0.771	af 26.00'W x 78.00'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
	•		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	1.2" Horiz. WQ Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Device 1	103.79'	,
			Limited to weir flow at low heads
#4	Device 1	105.60'	0.5' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

**Primary OutFlow** Max=0.48 cfs @ 15.25 hrs HW=105.99' (Free Discharge)

**—1=Culvert** (Passes 0.48 cfs of 29.80 cfs potential flow)

**2=WQ Orifice/Grate** (Orifice Controls 0.09 cfs @ 11.78 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.04 cfs @ 7.13 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 0.35 cfs @ 1.81 fps)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 5

## Summary for Pond 194P: P - P4 Pond

Inflow Area = 4.070 ac, 64.86% Impervious, Inflow Depth = 3.60" for 100-year Storm event

Inflow = 3.60 cfs @ 7.92 hrs, Volume= 1.221 af

Outflow = 0.62 cfs @ 12.65 hrs, Volume= 1.136 af, Atten= 83%, Lag= 283.9 min

Primary = 0.62 cfs @ 12.65 hrs, Volume= 1.136 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 106.07' @ 12.65 hrs Surf.Area= 0.164 ac Storage= 0.609 af

Plug-Flow detention time= 1,276.0 min calculated for 1.135 af (93% of inflow)

Center-of-Mass det. time= 1,227.2 min (1,916.6 - 689.4)

Volume	Invert	Avail.Stora	ge Storage Description
#1	100.00'	0.771	af 26.00'W x 78.00'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
	•		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	1.2" Horiz. WQ Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Device 1	103.79'	1.0" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#4	Device 1	105.60'	0.5' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

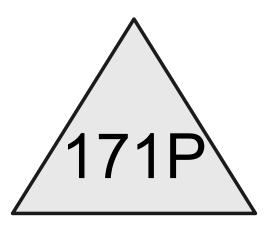
Primary OutFlow Max=0.62 cfs @ 12.65 hrs HW=106.07' (Free Discharge)

**-1=Culvert** (Passes 0.62 cfs of 30.07 cfs potential flow)

**—2=WQ Orifice/Grate** (Orifice Controls 0.09 cfs @ 11.87 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.04 cfs @ 7.28 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 0.49 cfs @ 2.05 fps)



# P - P5 Pond









Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015 Page 2

## Summary for Pond 171P: P - P5 Pond

Inflow Area = 5.280 ac, 71.59% Impervious, Inflow Depth = 1.86" for 2-year Storm event

Inflow = 2.40 cfs @ 7.92 hrs, Volume= 0.820 af

Outflow = 0.32 cfs @ 18.40 hrs, Volume= 0.778 af, Atten= 87%, Lag= 629.1 min

Primary = 0.32 cfs @ 18.40 hrs, Volume= 0.778 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 103.04' @ 18.40 hrs Surf.Area= 0.171 ac Storage= 0.407 af

Plug-Flow detention time= 901.9 min calculated for 0.777 af (95% of inflow)

Center-of-Mass det. time= 866.7 min ( 1,564.2 - 697.6 )

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	0.793	38.00'W x 114.00'L x 5.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
	•		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	0.9" Horiz. WQ Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Device 1	101.10'	2.8" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#4	Device 1	103.40'	3.0' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.32 cfs @ 18.40 hrs HW=103.04' (Free Discharge)

**-1=Culvert** (Passes 0.32 cfs of 19.06 cfs potential flow)

-2=WQ Orifice/Grate (Orifice Controls 0.04 cfs @ 8.40 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.29 cfs @ 6.71 fps)

**4=10/25-yr BCR Weir** ( Controls 0.00 cfs)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015 Page 3

## Summary for Pond 171P: P - P5 Pond

Inflow Area = 5.280 ac, 71.59% Impervious, Inflow Depth = 2.78" for 10-year Storm event

Inflow = 3.61 cfs @ 7.92 hrs, Volume= 1.225 af

Outflow = 0.84 cfs @ 10.06 hrs, Volume= 1.179 af, Atten= 77%, Lag= 128.7 min

Primary = 0.84 cfs @ 10.06 hrs, Volume= 1.179 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 103.55' @ 10.06 hrs Surf.Area= 0.184 ac Storage= 0.497 af

Plug-Flow detention time= 736.4 min calculated for 1.178 af (96% of inflow)

Center-of-Mass det. time= 710.8 min (1,399.6 - 688.8)

Volume	Invert	Avail.Stora	ige Storage Description
#1	100.00'	0.793	af 38.00'W x 114.00'L x 5.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
	•		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	0.9" Horiz. WQ Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Device 1	101.10'	2.8" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#4	Device 1	103.40'	3.0' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

**Primary OutFlow** Max=0.84 cfs @ 10.06 hrs HW=103.55' (Free Discharge)

**-1=Culvert** (Passes 0.84 cfs of 21.30 cfs potential flow)

-2=WQ Orifice/Grate (Orifice Controls 0.04 cfs @ 9.07 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.32 cfs @ 7.53 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 0.48 cfs @ 1.08 fps)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 4

## Summary for Pond 171P: P - P5 Pond

Inflow Area = 5.280 ac, 71.59% Impervious, Inflow Depth = 3.25" for 25-year Storm event

Inflow = 4.22 cfs @ 7.91 hrs, Volume= 1.431 af

Outflow = 1.39 cfs @ 8.97 hrs, Volume= 1.386 af, Atten= 67%, Lag= 63.3 min

Primary = 1.39 cfs @ 8.97 hrs, Volume= 1.386 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 103.64' @ 8.97 hrs Surf.Area= 0.187 ac Storage= 0.515 af

Plug-Flow detention time= 642.8 min calculated for 1.386 af (97% of inflow)

Center-of-Mass det. time= 619.0 min (1,304.4 - 685.4)

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	0.793	38.00'W x 114.00'L x 5.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
	•		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	0.9" Horiz. WQ Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Device 1	101.10'	2.8" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#4	Device 1	103.40'	3.0' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

**Primary OutFlow** Max=1.39 cfs @ 8.97 hrs HW=103.64' (Free Discharge)

**-1=Culvert** (Passes 1.39 cfs of 21.70 cfs potential flow)

**-2=WQ Orifice/Grate** (Orifice Controls 0.04 cfs @ 9.19 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.33 cfs @ 7.68 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 1.02 cfs @ 1.40 fps)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 5

## **Summary for Pond 171P: P - P5 Pond**

Inflow Area = 5.280 ac, 71.59% Impervious, Inflow Depth = 3.73" for 100-year Storm event

Inflow = 4.84 cfs @ 7.91 hrs, Volume= 1.640 af

Outflow = 2.16 cfs @ 8.40 hrs, Volume= 1.594 af, Atten= 55%, Lag= 29.3 min

Primary = 2.16 cfs @ 8.40 hrs, Volume= 1.594 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 103.75' @ 8.40 hrs Surf.Area= 0.190 ac Storage= 0.534 af

Plug-Flow detention time= 567.0 min calculated for 1.593 af (97% of inflow)

Center-of-Mass det. time= 548.0 min (1,230.5 - 682.5)

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	0.793	38.00'W x 114.00'L x 5.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
	•		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	0.9" Horiz. WQ Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Device 1	101.10'	2.8" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#4	Device 1	103.40'	3.0' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

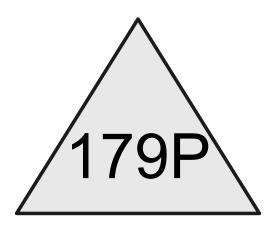
**Primary OutFlow** Max=2.16 cfs @ 8.40 hrs HW=103.75' (Free Discharge)

**-1=Culvert** (Passes 2.16 cfs of 22.13 cfs potential flow)

**-2=WQ Orifice/Grate** (Orifice Controls 0.04 cfs @ 9.32 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.34 cfs @ 7.84 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 1.78 cfs @ 1.71 fps)



# P - Q1 Pond









Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015

Page 2

## Summary for Pond 179P: P - Q1 Pond

Inflow Area = 10.230 ac, 56.01% Impervious, Inflow Depth = 1.64" for 2-year Storm event

Inflow = 3.99 cfs @ 7.94 hrs, Volume= 1.398 af

Outflow = 0.53 cfs @ 20.33 hrs, Volume= 1.339 af, Atten= 87%, Lag= 743.8 min

Primary = 0.53 cfs @ 20.33 hrs, Volume= 1.339 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 103.35' @ 20.33 hrs Surf.Area= 0.265 ac Storage= 0.716 af

Plug-Flow detention time= 931.9 min calculated for 1.339 af (96% of inflow)

Center-of-Mass det. time= 901.6 min ( 1,617.3 - 715.6 )

Volume	Invert	Avail.Stora	ge Storage Description
#1	100.00'	1.199	af 49.00'W x 147.00'L x 5.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
			L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	1.2" Horiz. WQ Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Device 1	101.05'	3.4" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#4	Device 1	103.50'	2.2' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

**Primary OutFlow** Max=0.53 cfs @ 20.33 hrs HW=103.35' (Free Discharge)

**-1=Culvert** (Passes 0.53 cfs of 20.47 cfs potential flow)

-2=WQ Orifice/Grate (Orifice Controls 0.07 cfs @ 8.82 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.46 cfs @ 7.31 fps)

**-4=10/25-yr BCR Weir** ( Controls 0.00 cfs)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015 Page 3

## Summary for Pond 179P: P - Q1 Pond

Inflow Area = 10.230 ac, 56.01% Impervious, Inflow Depth = 2.52" for 10-year Storm event

Inflow = 6.23 cfs @ 7.93 hrs, Volume= 2.147 af

Outflow = 1.46 cfs @ 10.18 hrs, Volume= 2.084 af, Atten= 77%, Lag= 135.4 min

Primary = 1.46 cfs @ 10.18 hrs, Volume= 2.084 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 103.77' @ 10.18 hrs Surf.Area= 0.279 ac Storage= 0.831 af

Plug-Flow detention time= 699.6 min calculated for 2.083 af (97% of inflow)

Center-of-Mass det. time= 680.4 min (1,386.8 - 706.4)

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	1.199	af 49.00'W x 147.00'L x 5.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
	•		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	1.2" Horiz. WQ Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Device 1	101.05'	
			Limited to weir flow at low heads
#4	Device 1	103.50'	2.2' long x 0.5' breadth 10/25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

**Primary OutFlow** Max=1.46 cfs @ 10.18 hrs HW=103.77' (Free Discharge)

**-1=Culvert** (Passes 1.46 cfs of 22.22 cfs potential flow)

2=WQ Orifice/Grate (Orifice Controls 0.07 cfs @ 9.35 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.50 cfs @ 7.94 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 0.89 cfs @ 1.48 fps)

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 4

## Summary for Pond 179P: P - Q1 Pond

Inflow Area = 10.230 ac, 56.01% Impervious, Inflow Depth = 2.97" for 25-year Storm event

Inflow = 7.40 cfs @ 7.93 hrs, Volume= 2.534 af

Outflow = 2.33 cfs @ 9.09 hrs, Volume= 2.471 af, Atten= 69%, Lag= 70.0 min

Primary = 2.33 cfs @ 9.09 hrs, Volume= 2.471 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 103.92' @ 9.09 hrs Surf.Area= 0.284 ac Storage= 0.871 af

Plug-Flow detention time= 607.5 min calculated for 2.471 af (98% of inflow)

Center-of-Mass det. time= 589.4 min (1,292.0 - 702.6)

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	1.199	9 af 49.00'W x 147.00'L x 5.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
			L= 100.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	·
#3	Device 1	101.05'	<b>3.4" Horiz. 2-yr Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#4	Device 1	103.50'	2.2' long x 0.5' breadth 10/25-yr BCR Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

**Primary OutFlow** Max=2.33 cfs @ 9.09 hrs HW=103.92' (Free Discharge)

**-1=Culvert** (Passes 2.33 cfs of 22.80 cfs potential flow)

**-2=WQ Orifice/Grate** (Orifice Controls 0.07 cfs @ 9.53 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.51 cfs @ 8.15 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 1.74 cfs @ 1.89 fps)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 5

## Summary for Pond 179P: P - Q1 Pond

Inflow Area = 10.230 ac, 56.01% Impervious, Inflow Depth = 3.43" for 100-year Storm event

Inflow = 8.59 cfs @ 7.92 hrs, Volume= 2.927 af

Outflow = 3.44 cfs @ 8.51 hrs, Volume= 2.864 af, Atten= 60%, Lag= 35.5 min

Primary = 3.44 cfs @ 8.51 hrs, Volume= 2.864 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 104.06' @ 8.51 hrs Surf.Area= 0.289 ac Storage= 0.913 af

Plug-Flow detention time= 535.7 min calculated for 2.864 af (98% of inflow)

Center-of-Mass det. time= 519.9 min (1,219.1 - 699.2)

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	1.199	9 af 49.00'W x 147.00'L x 5.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
			L= 100.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#2	Device 1	98.67'	·
#3	Device 1	101.05'	<b>3.4" Horiz. 2-yr Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#4	Device 1	103.50'	2.2' long x 0.5' breadth 10/25-yr BCR Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

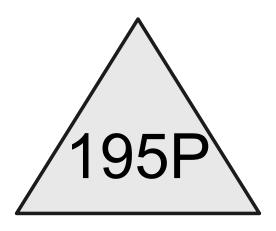
Primary OutFlow Max=3.44 cfs @ 8.51 hrs HW=104.06' (Free Discharge)

**-1=Culvert** (Passes 3.44 cfs of 23.36 cfs potential flow)

**-2=WQ Orifice/Grate** (Orifice Controls 0.08 cfs @ 9.71 fps)

-3=2-yr Orifice/Grate (Orifice Controls 0.53 cfs @ 8.36 fps)

**-4=10/25-yr BCR Weir** (Weir Controls 2.84 cfs @ 2.29 fps)



# P - Q2 Pond









Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015

Page 2

## Summary for Pond 195P: P - Q2 Pond

Inflow Area = 3.400 ac,100.00% Impervious, Inflow Depth = 2.27" for 2-year Storm event

Inflow 1.96 cfs @ 7.90 hrs, Volume= 0.643 af

0.10 cfs @ 24.07 hrs, Volume= Outflow 0.588 af, Atten= 95%, Lag= 970.2 min

Primary 0.10 cfs @ 24.07 hrs, Volume= 0.588 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 105.01' @ 24.07 hrs Surf.Area= 0.152 ac Storage= 0.499 af

Plug-Flow detention time= 2,122.0 min calculated for 0.587 af (91% of inflow)

Center-of-Mass det. time= 2,060.9 min (2,734.7 - 673.8)

Volume	Invert	Avail.Stora	age Storage Description
#1	100.00'	0.850	oaf 28.00'W x 84.00'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
	-		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	100.00'	1.3" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Device 1	105.65'	0.5' long x 0.5' breadth 10-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32
#4	Device 1	105.95'	6.0' long x 0.5' breadth 25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.10 cfs @ 24.07 hrs HW=105.01' (Free Discharge)

-1=Culvert (Passes 0.10 cfs of 26.74 cfs potential flow)

2=2-yr Orifice/Grate (Orifice Controls 0.10 cfs @ 10.78 fps)

-3=10-yr BCR Weir (Controls 0.00 cfs)

-4=25-yr BCR Weir (Controls 0.00 cfs)

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Printed 11/30/2015 Page 3

## Summary for Pond 195P: P - Q2 Pond

Inflow Area = 3.400 ac,100.00% Impervious, Inflow Depth = 3.27" for 10-year Storm event

Inflow 2.79 cfs @ 7.90 hrs, Volume= 0.926 af

0.31 cfs @ 19.53 hrs, Volume= Outflow 0.807 af, Atten= 89%, Lag= 698.1 min

Primary 0.31 cfs @ 19.53 hrs, Volume= 0.807 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 105.92' @ 19.53 hrs Surf.Area= 0.174 ac Storage= 0.647 af

Plug-Flow detention time= 1,952.3 min calculated for 0.807 af (87% of inflow)

Center-of-Mass det. time= 1,862.0 min ( 2,526.1 - 664.0 )

Volume	Invert	Avail.Stora	ge Storage Description
#1	100.00'	0.850	af 28.00'W x 84.00'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	24.0" Round Culvert
	•		L= 100.0' RCP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900
			n= 0.013, Flow Area= 3.14 sf
#2	Device 1	100.00'	1.3" Horiz. 2-yr Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Device 1	105.65'	0.5' long x 0.5' breadth 10-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32
#4	Device 1	105.95'	6.0' long x 0.5' breadth 25-yr BCR Weir
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.31 cfs @ 19.53 hrs HW=105.92' (Free Discharge)

-1=Culvert (Passes 0.31 cfs of 29.61 cfs potential flow)

2=2-yr Orifice/Grate (Orifice Controls 0.11 cfs @ 11.72 fps)

**-3=10-yr BCR Weir** (Weir Controls 0.20 cfs @ 1.48 fps)

-4=25-yr BCR Weir (Controls 0.00 cfs)

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 4

## Summary for Pond 195P: P - Q2 Pond

Inflow Area = 3.400 ac,100.00% Impervious, Inflow Depth = 3.77" for 25-year Storm event

Inflow = 3.20 cfs @ 7.90 hrs, Volume= 1.067 af

Outflow = 0.45 cfs @ 14.92 hrs, Volume= 0.947 af, Atten= 86%, Lag= 421.5 min

Primary = 0.45 cfs @ 14.92 hrs, Volume= 0.947 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 105.98' @ 14.92 hrs Surf.Area= 0.176 ac Storage= 0.657 af

Plug-Flow detention time= 1,716.6 min calculated for 0.947 af (89% of inflow)

Center-of-Mass det. time= 1,636.3 min ( 2,297.1 - 660.7 )

Volume	Invert	Avail.Storage	ge Storage Description
#1	100.00'	0.850	af 28.00'W x 84.00'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary		24.0" Round Culvert
		100.00	L= 100.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100' /' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#2	Device 1	100.00'	<b>1.3" Horiz. 2-yr Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#3	Device 1	105.65'	<b>0.5' long x 0.5' breadth 10-yr BCR Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#4	Device 1	105.95'	6.0' long x 0.5' breadth 25-yr BCR Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.45 cfs @ 14.92 hrs HW=105.98' (Free Discharge)

**-1=Culvert** (Passes 0.45 cfs of 29.77 cfs potential flow)

2=2-yr Orifice/Grate (Orifice Controls 0.11 cfs @ 11.77 fps)

-3=10-yr BCR Weir (Weir Controls 0.27 cfs @ 1.64 fps)

**-4=25-yr BCR Weir** (Weir Controls 0.07 cfs @ 0.45 fps)

Prepared by Otak, Inc.

HydroCAD® 10.00 s/n 05469 © 2013 HydroCAD Software Solutions LLC

Page 5

## Summary for Pond 195P: P - Q2 Pond

Inflow Area = 3.400 ac,100.00% Impervious, Inflow Depth = 4.26" for 100-year Storm event

Inflow 3.61 cfs @ 7.90 hrs, Volume= 1.208 af

0.60 cfs @ 11.68 hrs, Volume= Outflow 1.088 af, Atten= 83%, Lag= 227.0 min

Primary 0.60 cfs @ 11.68 hrs, Volume= 1.088 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.05 hrs / 3 Peak Elev= 106.00' @ 11.68 hrs Surf.Area= 0.176 ac Storage= 0.661 af

Plug-Flow detention time= 1,522.0 min calculated for 1.087 af (90% of inflow)

Center-of-Mass det. time= 1,451.2 min (2,109.3 - 658.1)

Volume	Invert	Avail.Stora	ge Storage Description
#1	100.00'	0.850	af 28.00'W x 84.00'L x 7.00'H Prismatoid Z=3.0
Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	<b>24.0" Round Culvert</b> L= 100.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#2	Device 1	100.00'	<b>1.3" Horiz. 2-yr Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#3	Device 1	105.65'	<b>0.5' long x 0.5' breadth 10-yr BCR Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#4	Device 1	105.95'	6.0' long x 0.5' breadth 25-yr BCR Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.60 cfs @ 11.68 hrs HW=106.00' (Free Discharge)

-1=Culvert (Passes 0.60 cfs of 29.85 cfs potential flow)

2=2-yr Orifice/Grate (Orifice Controls 0.11 cfs @ 11.79 fps)

**-3=10-yr BCR Weir** (Weir Controls 0.30 cfs @ 1.71 fps)

**-4=25-yr BCR Weir** (Weir Controls 0.19 cfs @ 0.63 fps)